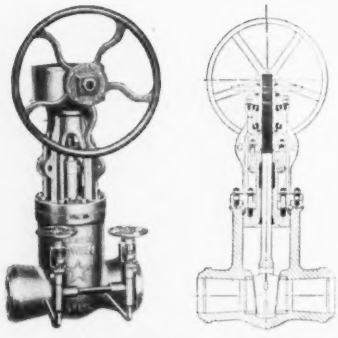
# THE CORNELL ENGINEER

COLLEGE OF ENGINEERING · CORNELL UNIVERSITY

*Another page for* **YOUR BEARING NOTEBOOK**



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Big, heavy-duty pipeline valves have to be designed so that they can be opened and closed in a jiffy with a minimum of effort. To meet this problem, engineers mount the turning mechanism on Timken® tapered roller bearings. Timken bearings take both the radial and thrust loads imposed by the valve action. And they reduce friction to a minimum.

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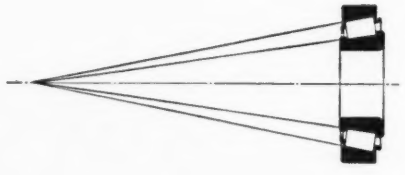
Timken bearings are a precision product, manufactured to microscopic tolerances and finished to incredible smoothness to assure true rolling motion. The diagram at the right shows clearly how true rolling motion is obtained. Notice that lines produced coincident with the faces of the rollers, cup and cone meet at a common point at the axis of the bearing.



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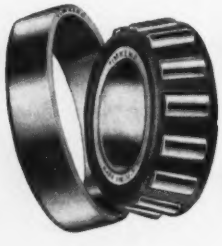

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TRADE-MARK REG. U. S. PAT. OFF.
**TAPERED ROLLER BEARINGS**

## Learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing problems. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

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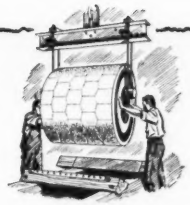
**NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬭ AND THRUST ⬭ LOADS OR ANY COMBINATION ⬭**



## *What's it for?*

**This 10-ton abrasive wheel helps produce which of the following?**

- ☐ *Steel*
- ☐ *Paper*
- ☐ *Cement*
- ☐ *Coal*

The answer is paper and the wheel is a Norton pulpstone, used in the grinding of wood pulp.

### *How It's Made*

In the Norton pulpstone, abrasive segments are anchored securely to a reinforced concrete center, and staggered to comprise a continuous grinding surface. Depending on pulp requirements, the abrasive mediums are Crystolon* silicon carbide or Alundum* aluminum oxide, both trade-marked Norton products noted for their great hardness, sharpness and high resistance to wear. Joints between segments are made of a special material which is unaffected by continuous immersion in hot water and has a wear-resistance approximating that of the abrasive.

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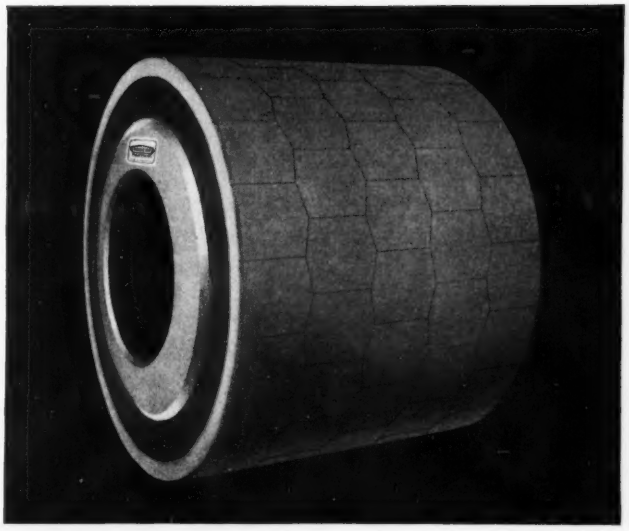
Thanks to their scientific construction, and to the constant care that controls their manufacture, Norton pulpstones are, above all, quality producers. In addition, their extremely low wearing rates enable mills to obtain a higher yield of pulp per cord of wood and to reduce expensive, production-halting shutdowns due to stone replacements. That is why Norton pulpstones are preferred by wood pulp mills the world over.



John R. Erickson, B. S., Yale '33, checks a newly molded Reinforced Hub Wheel in the Norton Research Laboratory — Organic Section.

### *Worth Thinking About*

Norton engineers and the facilities of Norton laboratories are constantly at work on new developments in abrasives, bonds, construction methods and applications. In other words, "making better products to make other products better" — for *all* industry. To the young technician, it is a constantly expanding, exceptionally inviting field — worthy of serious consideration when planning for the future.

Guy Irwin, Ph. D., Penn State '49, working on the development of ceramic bonds, examines vitrified grinding wheel under a binocular microscope.

*Registered trade-marks for Norton silicon carbide and aluminum oxide respectively.

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# NEW FLORSHEIM "DREAM HOME"

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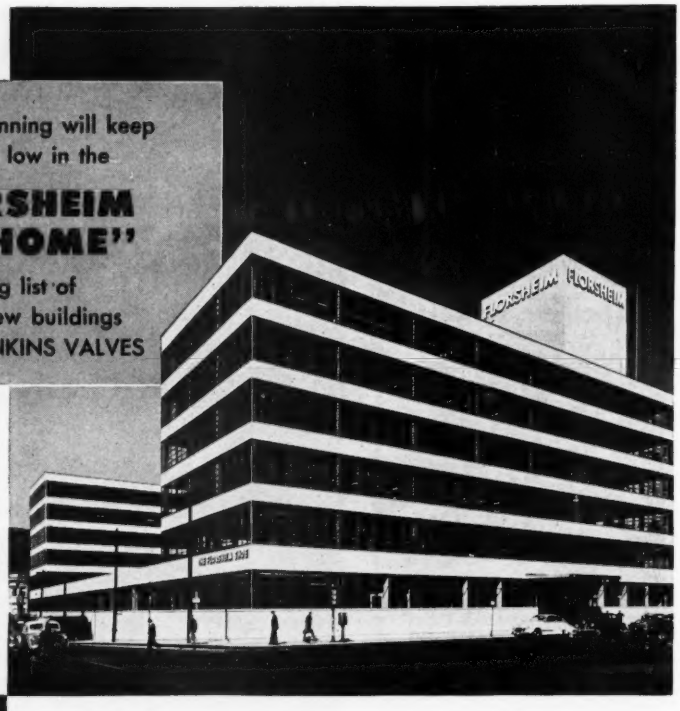


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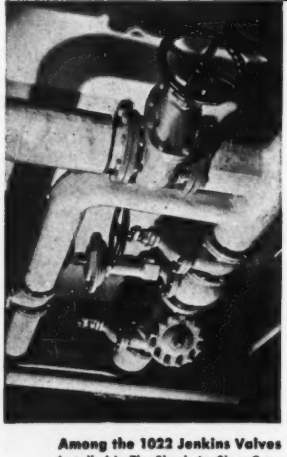

**Among the 1022 Jenkins Valves** installed in The Florsheim Shoe Company's combined factory-and-office building are these gate valves in the steam distribution lines of the heating system. Other Jenkins bronze, iron, and steel valves control water, air-conditioning, and such vital lines.

With its unbroken horizontal tiers of grey brick curtain walls which "seem to float in thin air", acres of glass their only visible means of support, the new home of The Florsheim Shoe Company in Chicago might be called an industrial "dream home".

It is certainly one of America's most notable examples of future-minded planning. Like the production machines used in cutting, lasting, stitching, and finishing Florsheim Shoes, the equipment installed for building operation is the most efficient modern engineering has devised. Here, Jenkins Valves "fit perfectly".

In fact, because of their dependability, safety and lasting economy, Jenkins Valves have been the choice, consistently, of leading architects, engineers and contractors for the towering skyscrapers, huge industrial plants, and super airports that are making today's building news.

They know Jenkins builds extra endurance into valves — proved by low upkeep cost records in every type of service. Yet, despite this extra value, *they pay no more* for Jenkins Valves. For new installations, for all replacements, the Jenkins Diamond is their guide to lasting valve economy.
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Dowanols are but one of a wide range of products resulting from a program of continuing research carried on by Dow in the interest of producing more "Chemicals Indispensable to Industry and Agriculture."

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# How to build a span in 5 days

## at only $2.00 per square foot

Building the first Americanized Prestressed-Concrete Bridge. Crane which exceeds designed load capacity of the bridge operates safely on the unfinished span before its concrete slab has been laid or lateral prestressing applied.

The bridge, located in Madison County, Tennessee, was designed by Bryan and Dozier, of Nashville . . . built by Madison County Highway Dept. under supervision of Edwin C. Rogers, County Engineer. Concrete blocks by Nashville Breeko Block & Tile Co.

Swinging the assembled concrete beams into place to form the deck cover for the bridge. Beams are only 11⅝" deep.

Americanized Prestressed Concrete employs special galvanized cold drawn steel wire and specially designed fittings. It is these recent Roebling developments which make possible this type of construction.

IN OCTOBER the first Prestressed-Concrete Bridge in the United States was put in service. Its roadway, designed for a 15-ton load, was of an entirely new design which permitted amazing speed of construction and cost only $2.00 per square foot. With the experience gained, it is estimated that similar spans to be built will be erected in five days—ready for traffic in 14 days—and at an even lower cost.

The span is made up of beams formed of machine-made concrete blocks laid horizontally with mortar joints. Two Roebling Prestressed-Concrete Galvanized Strands running through longitudinal holes in the blocks were placed under tension, converting each beam into a self-contained monolithic concrete unit. After the beams were erected in place, the span was covered with a continuous, mesh-reinforced concrete slab and laterally prestressed when the concrete had cured to strength.

Americanized Prestressed-Concrete, employing special cold drawn steel wire and specially designed fittings, is an exclusive Roebling development. It makes available a new construction material with an exceptional strength-weight ratio . . . a material economical in itself and a real time-saver! Its potentials quickly recognized, it has already been adopted in several structures, including use for floors and roof of a large commercial building now under construction.

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# The CORNELL ENGINEER

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**Cover:** Cornell students on the air: George Klein, Ag '52, is cued in by Paul Seidel, EE '54.

*Photo by Robert Stuckleman, EE '54*

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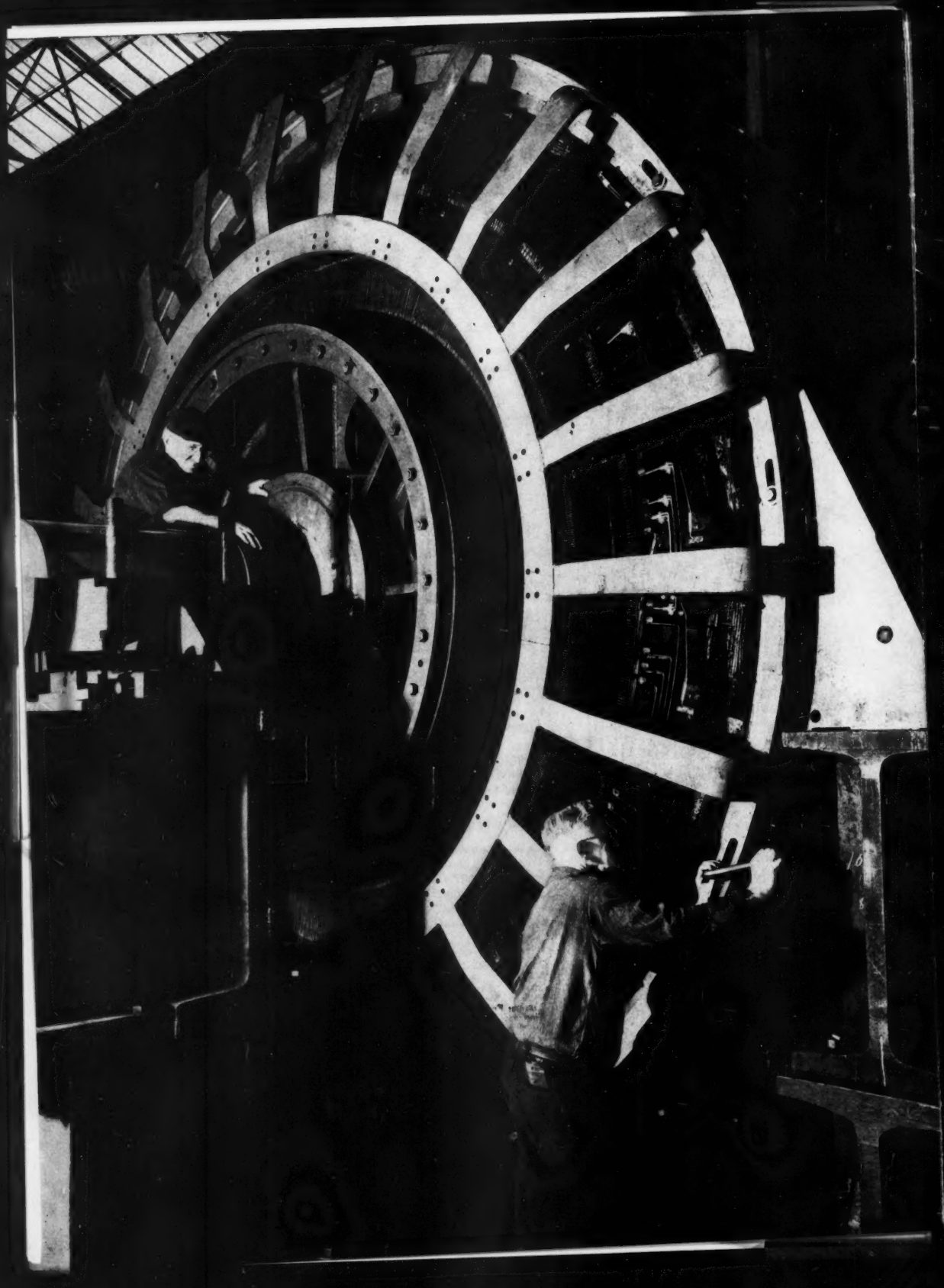


# The Future of Atomic Power

By JANICE BUTTON, EP '54

*Illustrations courtesy General Electric Company*

What has happened to the predicted Utopian world of atomic power? Where are the cars with built-in fuel and the home furnaces run by pea-sized chunks of uranium? These and other predictions of an atomic age with cheap power available to irrigate the Sahara desert and to melt the Greenland ice-cap for cultivation now seem ridiculous, and other more feasible uses of atomic energy appear to be rather far in the future.

In 1945, the Smyth Report stated that "the technological gap between producing a controlled chain reaction and using it as a large-scale power source is comparable to the gap between the discovery of fire and the manufacture of the steam locomotive." According to former A.E.C. Chairman David Lilienthal, atomic energy will be only a "supplemental power source in the foreseeable future."

### Obtaining U-235

There are many technical and economic problems to be solved in the development of atomic power for industrial use. A nuclear reactor or atomic pile, used to produce a controlled chain reaction of nuclear fission, gives off a great amount of heat which may be converted to electrical or propulsive power. Theoretically, one pound of uranium will give energy equivalent to that of 360,000 gallons of gasoline or two million pounds of coal; 45 tons of uranium would supply all the power needed by the United States for a year. However, all the known uranium deposits in the world could supply the power needs of the United States for only a few months. Uranium is the 25th most plentiful element, 1000 times as plentiful as gold, but even high-grade deposits yield only a fraction of a per cent of uranium. Low-grade ores are plentiful, but are difficult to mine. Almost no good deposits are found in the United States. Further, only 0.7% of uranium is the fissionable U-235. This small fraction may be separated from the stable U-238 isotopes only by a slow, difficult process such as gaseous diffusion or electro-magnetic separation. U-238 may be converted to plutonium by neutron bombardment, but in either case, the amount of fissionable material obtained is very small.

**This 3,000 horsepower motor, believed to be the largest mine hoist motor in physical size ever built in this country, is capable of lifting 12 tons of ore nearly half a mile a minute.**

*—Courtesy General Electric*

### Reactor Problems

Unless the uranium used in a pile is enriched (high percentage of U-235), the neutrons flying about within the pile must be slowed down to reduce absorption by the U-238. Moderators such as heavy water, berylluim, or graphite are used for this purpose. The odds in favor of a chain reaction are still not very high, however; very pure uranium must be used, and the spacing of the uranium lumps carefully calculated. Once the pile is started, fission products contaminate the material, and the uranium slugs must be periodically reprocessed by a slow expensive operation. Dr. Lawrence Hafstad, Director of Reactor Development for the Atomic Energy Commission, said that it is considered quite a job to have airplane engines broken down, inspected, overhauled, and reassembled every 800 hours. "Suppose that instead of merely disassembling, the entire engine would have to be dissolved in nitric acid, and the rebuilding of the engine started with the getting of a solution of chemically pure iron. This," he said, "would be comparable to the reprocessing necessary to maintain a reaction in an atomic pile."

A major problem in the building of nuclear reactors is the selection of materials. The high-energy radiation of the pile makes designing of the structure very difficult; materials chosen for certain physical properties may change in internal structure under this penetrating radiation to form new substances with entirely different properties. If radiation can change nitrogen to carbon and silicon to phosphorus, what will happen to tungsten steel? Moreover, if much of the structure absorbs neutrons, the power of the pile will be greatly reduced. Many strange, new materials are now being studied by scientists and metallurgists in an attempt to eliminate this difficulty.

Heat transfer is another big problem. Water from the Columbia River is used as a coolant at Hanford, but for generating power, a more efficient method is needed. The problem of finding something which will transfer heat more rapidly may be answered by liquid metals, such as gallium. These are rather hard to handle, though, and present new problems for the metallurgist.

Cadmium rods may be used to accelerate or brake a chain reaction. Controls must be located at a safe distance from the pile, and various ingenious devices have been developed to solve some of the problems of control. A thick concrete shield adds to the weight of the pile and to its size, which may

vary from that of a small living-room to a five-story building.

Some difficulty has already been caused by the disposal of wastes. If it were possible to supply all the United States with atomic power, we would be faced with the problem of disposing of substances equivalent in radioactivity to 100,000 tons of radium. It has been suggested that the wastes be put in concrete blocks to be dumped at sea or deposited in abandoned oil or gas wells, but nothing yet proposed seems feasible.

This small-scale model of an atomic pile shows cylinders of uranium projecting from the top of the pile. The striped rods represent cadmium moderators.

**Economic Factors**

Even if all these obstacles were in time overcome, there is a still greater problem to consider. Atomic power cannot at present compete economically with electric power furnished by water and coal, and it is doubtful whether it ever will. The Atomic Energy Commission has reported that the cost of an atomic power plant would be approximately twelve times that of an ordinary processing plant, whereas the operating expense would be about three times the ordinary. It has been estimated that the fixed cost per kilowatt capacity of atomic power would be about $2688 as compared to $133 per kw for power from burning coal. Edward U. Condon, Director of the National Bureau of Standards stated, "I do not think that in our economy, with its supplies of coal and water power, the development of atomic power will have any revolutionary effects." Lilienthal has said that the cost of building a reactor and getting it into operation would be about $50,000,000.

Of course, the situation would be different in undeveloped areas poor in coal and water power. And even though atomic power would have to improve tremendously to compete with conventional sources of power under ordinary conditions, it sometimes happens (as in the case of aluminum saucepans and Diesel engines) that devices too expensive for ordinary use are made available through their development for other purposes. The development of atomic energy for military needs may do for industry what the development of Diesel engines in the submarine did for the locomotive. In answer to the fears of some that the military program is hindering the development of atomic energy for peace-time use, Dr. Hafstad (Reactor Development Director for AEC) declared, "Power will be because of, not in spite of, military needs."

Four new-type reactors are now being developed by scientists working in the national laboratories and in industry. One of these, the Experimental Breeder Reactor, or "Operation Bootstrap," as it has been called, may be the solution to the problem of fuel scarcity.

The fission of a U-235 isotope produces one to three neutrons, one of which is needed to maintain the chain reaction. Heretofore, the efficiency of reactors has been such that the amount of plutonium produced as a by-product of a chain reaction has been less than the amount of U-235 consumed in the reaction. By reducing absorption and escape of neutrons, it is possible to raise the efficiency and further utilize neutrons not used to maintain the reaction, slightly more fission material being produced than is consumed.

In simpler language, if 140 pounds of uranium are put in an ordinary reactor, the one pound of U-235 present might produce from the U-238 one-half pound of plutonium, which could itself be used to maintain the reaction after the U-235 is gone. The one-half pound of plutonium might in turn give another one-fourth pound plutonium, but at this rate the fuel would soon be exhausted, and the reaction would die out. However, if the reactor were of better design, the one pound of U-235 might produce one pound of plutonium, and the process could maintain itself until all 140 pounds of the uranium were used up, with a possible power generation of ten million kw. per pound. And if the reactor were still more efficient, a little more than one pound of plutonium might be produced for every pound of U-235; thus the "breeding" of fission material for bombs or for more fuel would be possible. With perfect breeding (that is, with the conversion of all the U-238 to plutonium), the supply of fission material would be multiplied by 140. Thorium, which is a radioactive substance seven times more plentiful than uranium, may be converted similarly to fissionable U-233.

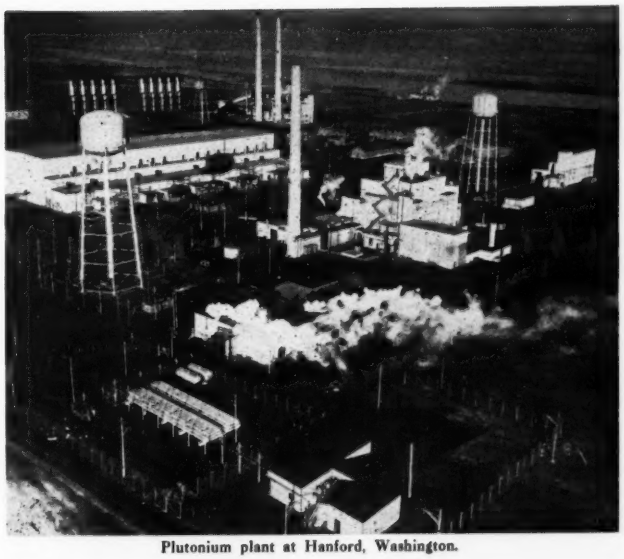
The design of the Experimental Breeder Reactor was completed at Argonne National Laboratories in Chicago by last November, and the small, cheap ($3,000,000) reactor is being built at the new 400,000

acre reactor testing station at Arco, Idaho. It will be a "fast-neutron" reactor as contrasted to the present models in which neutrons are slowed down. Enriched uranium will be used for fuel with probably less moderator needed. The reactor will be run at a high temperature with a liquid metal coolant, and will give a small amount of power. It will probably be in operation sometime early this year.

### Present Projects

The three other new reactors have been in the planning stage for some time, but in each case the projects have been slower and costlier than had been hoped. The Materials Testing Reactor, to be built at Arco, Idaho, late this year or in 1952, will have the specific job of providing intense neutron bombardment for the study of materials needed for reactor construction. Big and expensive ($25,000,000), it will be purely a research instrument and may solve some of the difficulties of aircraft power, such as the need for light-weight shielding and the generation of propulsive power without boilers.

Construction of a submarine engine has been give high priority and is now under way. Designed by Westinghouse working in conjunction with Argonne Laboratories, the reactor is being built at Arco and is expected to be finished in 1952. The Westinghouse engine will be equipped with a power takeoff, and the Navy is already designing a submarine in which the engine can be installed. This atomic sub will have the advantages of not having to surface for air or stop for refueling.



Plutonium plant at Hanford, Washington.

### Atomic Central Station

Plans were made for a pilot model of a central-station power plant as a General Electric project. Known as the "Intermediate Power-Breeder Reactor," it was expected to breed a little fuel as well as provide a considerable amount of power. However, this project was slow in development, and cost estimates were high. The program was partly a casualty of the Soviet bomb announced near the end of 1949, for the sub engine development and other projects were then given higher priority, and the G.E. plans were cancelled by the Atomic Energy Commission. Since heat transfer and other problems are the same, the naval reactor work will undoubtedly aid in the future construction of an industrial power pilot plant.

**Schematic diagram of an atomic power plant showing the utilization of heat from the pile to generate steam for producing mechanical energy in a steam turbine. The radioactive fluid used for heat transfer is kept in a closed cycle.**

DIAGRAM OF ATOMIC POWER PLANT

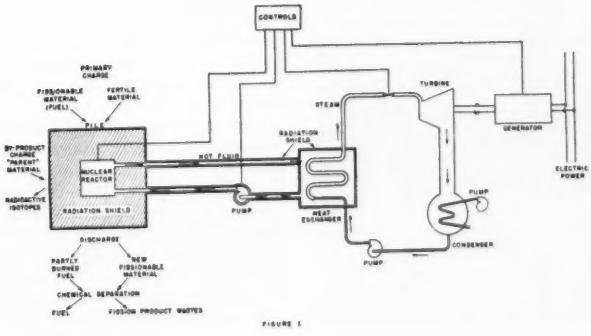



FIGURE 1

### New Submarine Engine

The building of a second submarine engine is the new job at the G.E. Knolls Atomic Power Laboratory in Schenectady. G.E. is now designing for the Navy a shipboard atomic plant, a medium-speed reactor with liquid metal coolant. It will operate at a very high temperature, and the heat produced will be transferred to the liquid metal in a closed low-pressure system and thence to a boiler where steam will be generated to drive turbines. Known as the "Ship Intermediate Reactor," the G.E. engine will differ considerably from the nearly completed Westinghouse "Ship Thermal Reactor" discussed above. This submarine engine is a slow neutron reactor which will use not a liquid metal coolant, but something different, such as helium gas. These two reactors must be of a size and shape to satisfy Navy specifica-

(*Continued on page* 34)

# Ring Out, Ye Bells!

**A DISCUSSION OF THE HISTORY AND TECHNOLOGY OF THE CORNELL CHIMES**

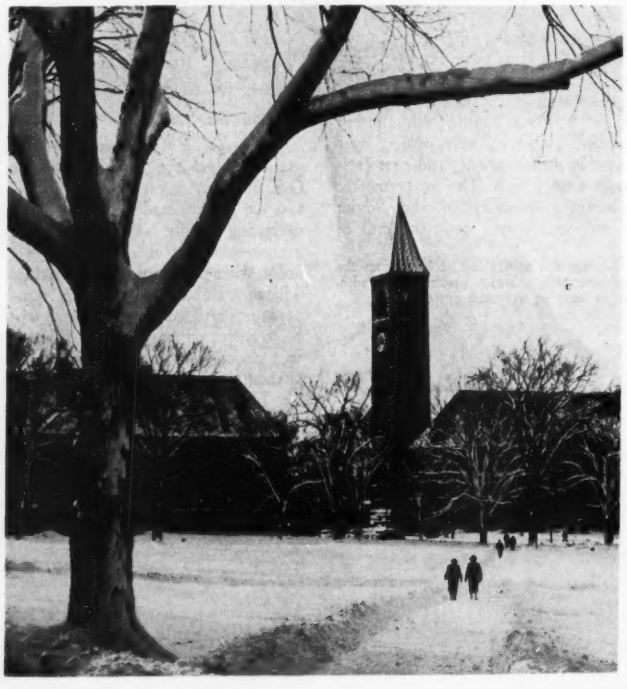
By PHILIP F. GOTTLING, JR., ME '52

*Illustrations courtesy the author*

As old as the University itself, the Cornell Chimes are a major institution and tradition of campus life, just as their "Libe" Tower has become a symbol of Cornell. In addition to their peremptory ringing which hurries students to eight o'clock classes, the bells ring out melodies at noontime, close each day with the evening program, herald athletic victories, commemorate special patriotic and University occasions, carol on Christmas Eve, and ring in the New Year. Indeed, the music of the bells becomes a lasting part of the memory of Cornellians.

Interest in the bells, on the part of students and other visitors, many of whom climb the 162 steps to the top of the tower, is demonstrated by the numerous questions put to members of the chimes staff; the most frequent query is: "Why do the bells sound out of tune?" It is in order to answer fully this question, as well as others of both a technical and historical nature, that this article is presented.

**The stately Library Tower houses a truly fine musical instrument, as all Cornellians will testify. The famous Chimes have given music to the campus since the University's founding.**



### History of the Bells

Let's begin with a brief history of the bells. The manufacture of the original chime of nine bells was a notable achievement because of the time element. Miss Jennie McGraw, a close friend of Ezra Cornell who sympathized with his educational aim, wanted to make an appropriate gift, but did not make her choice until less than three weeks before the formal opening of the university on October 7, 1868. In order that the bells be on the campus for that occasion they were molded, cast, and delivered in eighteen days. A temporary tower on the site of the present library housed the bells for their dedication and first ringing.

A year later, a tenth bell, the "Great Tenor," weighing nearly 5,000 pounds, was added by President Andrew White in behalf of Mrs. Mary A. White. This bell, corresponding in pitch very nearly to middle C, is the hour bell, and the lowest in pitch of the present chimes.

In the summer of 1872 the chimes were moved from their temporary location to the tower of McGraw Hall, where they remained until the Library Tower was completed in 1888. The ten bells were removed from the tower in June, 1908, and all but the two largest were then recast and tuned. Removal of the bells was a major task, since a clock

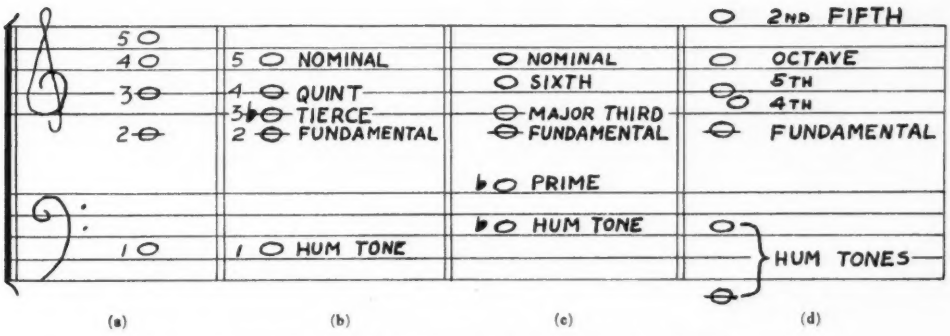



**Figure 1—Overtones produced by bells compared with those of vibrating strings and open pipes.**

face and much of the upper tower structure had to be removed to provide a passage for the heavier bells, too large to fit between the columns at the open part of the structure. At the time of this recasting, four new bells were added to the set.

Two more bells, bringing the total number to sixteen, and a more modern playing stand were acquired in 1928. In 1938 the most recent addition of two bells brought the chimes to their present number of eighteen bells. The chromatic scale, in its present form, encompasses about one and a half octaves, and is continuous from middle C to the second G above, with the exception of the lower D-flat and E-flat bells.

Technically and musically, bells can be the subject of a most interesting study. In the musical sense, they are different in every way from all other instruments. Their production of sound is by a very complex vibration behavior which is not yet fully understood.

### Standard Musical Notes

Before we consider the musical tone of a bell, it would be well to review briefly the more commonplace situation found in stringed or wind instruments. Every musical note, almost without exception, is composed of a number of different "pure" tones produced simultaneously by the instrument. (A pure tone is a simple tone represented by a sinusoidal wave of audible frequency). One of these simple tones, usually the lowest in frequency or pitch, is much louder than the others and may seem to be the only one present. It is by this tone that the note is named. The higher tones produced at the same time by the instrument are known as overtones; while the overtones may not be obvious to the ear, it is their number, frequencies, and intensities which make the note of one instrument sound different than a note of apparently the same pitch of another instrument. In most instruments, the frequencies of all the overtones are exact multiples of the frequency of the lowest, most obvious tone; in this most general case, the entire group of tones are known as harmonics.

In the case of instruments producing such a harmonic series of tones, all of the overtones are automatically tuned to the correct pitch when the lowest, most prominent tone, is tuned.

### Theory of Bell Tones

Bell tones present quite a different picture. Not only do the overtones (in the case of bells these are called "partials") fail to observe the orderly, harmonic series, but each partial must be individually tuned. This tuning process, which will be described later, is necessary if bells are to be struck together in harmony, as on a carillon. Tuning is not so important if a bell is to be sounded alone; an untuned bell will have partials bearing an inharmonious relationship to each other, but the resulting sound is not necessarily disagreeable. The carillon, however, could not produce pleasing, effective harmony if two or more bell notes sounded together were themselves composed of an array of inharmonious overtones. A satisfactory carillon bell must have at least the first five partials tuned to the correct relationship, so that prominent partials of one bell will not "clash" with those of another bell when several bells are struck together in a chord.

At this point the distinction between a carillon and ordinary chimes becomes clear. The Carillon Guild, at its meeting at Princeton University in 1946, adopted the following definition:

"A carillon is an instrument comprising at least two octaves of fixed cup-shaped bells arranged in a chromatic series and so tuned as to produce, when many such bells are sounded together, concordant harmony . . . "

The ordinary chime of bells is not sufficiently tuned to meet this requirement.

Figure 1 shows, for comparison, the more prominent overtones present in musical notes of different origins. Part (a) shows the first five tones produced by vibrating strings and open pipes; the upper four tones represent vibrations two, three, four, and five times the frequency of the lowest tone—the C in the Bass Clef—a tone arbitrarily chosen for illustration. These tones represent the theoretical harmonic series; in most such musical notes, the lowest tone would have the greatest amplitude, or volume.

The second illustration on the staff shows the first five partial tones of a properly tuned carillon bell of which the lowest tone, though in this instance not the loudest, is the same C. In such a tuned bell, the loudest tone is the second partial, an octave above the lowest, while the fourth partial, two octaves above, may be equally

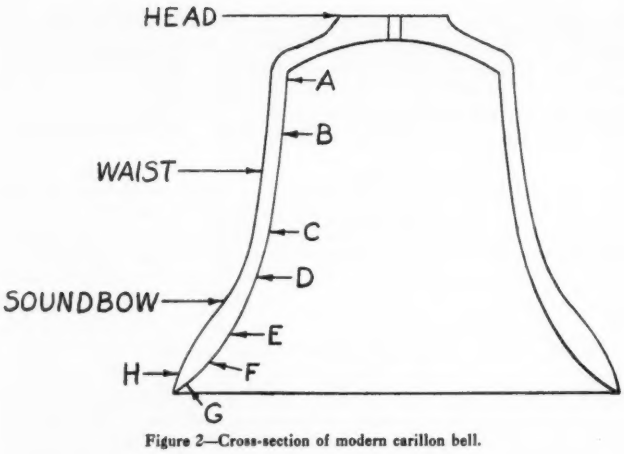



**Figure 2—Cross-section of modern carillon bell.**

prominent. The lowest partial has been called the hum tone, because it persists long after the others have died away. The second partial, which becomes prominent shortly after the bell is struck, is called the fundamental, because it is the tone most obvious to the ear. The fourth partial, two octaves above the hum tone, is called the nominal; it appears with surprising promptness and vigor at the instant of striking, but rapidly loses amplitude. The two other tones shown, the tierce and the quint, are of sufficient amplitude to dictate tuning for proper carillon performance. Of course, many higher partials not shown are present. These affect the timbre or quality of the note, but do not determine its purity.

We now have established sufficient background to explain why the Cornell Chimes sound out of tune. Part (c) of Figure 1 shows the prominent partial tones occurring in typical, untuned chime bells such as those of Cornell. In such bells, only the fundamental has been tuned. The other tones depend upon the shape of the bell, varying with minute changes in section. Thus, from one bell to the next the partials which are not tuned may vary as much as two half tones from the relative positions shown. For this reason, the most prominent tones, the fundamentals, form a reasonably good musical scale, while the random relationship of partial tones makes the bells seem unmatched, or of different timbre, and makes the result of any attempt to combine several bells into harmony seem discordant. This, in a nutshell, is the situation of the Cornell Chimes. Bells such as these were designed to be played one at a time—never in chords or harmony.

Part (d) of the sketch illustrates, as a further comparison in the series, the partials present in tubular chimes, a recent development in belfry installations. These are not true bells, nor do they sound like bells; but attempts have been made to use them as a substitute. Although their notes are long-sounding and not unpleasant, they are composed of a very peculiar series of overtones which makes them unsuitable for the realization of harmony.

### Bell Design

Figure 2 shows the cross section of a modern bell of the carillon type, whose height is equal to its larger diameter or twice its smaller diameter. On the sketch are shown the zones in which the five principal partial tones may be tuned by turning the bell on a lathe after the initial casting is made. According to modern practice, the casting is made in such a way that all of the tones are somewhat higher than the required pitch. Then the bell is placed in the lathe, using a vertical axis of rotation for the larger bells, and metal is removed from the appropriate places very slowly, accompanied by frequent tests with tuning forks or other equipment to supply accurate reference tones, until the proper relationship of partials is obtained. This tuning, done only when the bell is made, remains unvaried until centuries of pounding have changed the crystal structure of the metal and the resonance is lost.

The form of the present bell, its shape, size, and thickness, are the results of several centuries of experience and experimentation carried on in an effort to improve the character of the note, and can be derived directly by no definite theory. Approaches to bells of this shape were first made in the low countries of Europe, Holland and Belgium in particular, but it has been only during the past thirty or forty years that the art has developed in the United States.

### Carillon Construction

In building a carillon, the diameter of the largest bell and its weight are fixed, and the other bells are designed proportionally. Bells of similar form vary in pitch as their homologous, or proportional, dimensions. Furthermore, the pitch becomes lower as the ratio of thickness to total weight of metal decreases. In most carillons, bells in the lower part of the range maintain a proportional relationship and have similar shapes. A bell half the diameter of another of like form would weigh about one seventh as much and would produce a note an octave higher. Bells at the upper end of the register cannot maintain this homologous relationship as they would become so small that their sound would not carry. In the smallest bells, the diameter diminishes less rapidly; their pitch is raised by thickening the wall of the bell. The extreme example of this procedure is in the carillon of Saint-Germaine-l'Auxerrois in Paris, where the thirteen smallest bells are of equal diameter, the difference in pitch being achieved entirely by varying their thickness.

Visitors to the "Libe" Tower, after expressing varied comments on the tone of the bells, often wonder why a mechanically or electrically-powered mechanism is not available to reduce the effort required of the chimesmaster in ringing the

*(Concluded on page 30)*

# ELECTRONIC COMPUTERS

By NOBORU KONDO, ME '51

*Illustrations courtesy National Bureau of Standards*

Did you know that 99,999,999,977 has no factors and is therefore a prime number? If you want to prove it for yourself, all you have to do is to try dividing it by 80,000 different trial divisors. Working eight hours a day with a desk calculator, it should take you about two months—if you don't give up. Last spring a certain "brain" finished off this little chore in thirty minutes. This "brain," however, wasn't human; it was the National Bureau of Standards Eastern Automatic Computer—familiarly known as SEAC. Though the above computation has little practical value, it does indicate the incredible speed that modern automatic computing machines have attained.

**Basic Computer Parts**

Computations may be carried out in two ways: by analogy in which the result desired is manifested as a physical characteristic that must be measured (e.g. length, voltage, etc.), or by discrete numerical units, that is digits, though not necessarily in the decimal system. Because it doesn't accumulate an enormous error and can solve the widest variety of problems, the numerical (or digital) computer is far more preferable. High speed operation makes electronic switching practically imperative, since mechanical relays are limited by their inherent inertia.

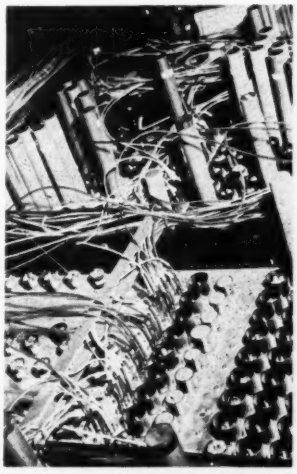
To form a complete computing system, the following parts are essential:

1. External memory — records and preserves data in a form directly transferable to the computing machine.
2. Input mechanism — transfers information from external memory to machine.
3. Computing element — performs the necessary arithmetical and logical operations on the information.
4. Internal memory—stores information needed later in the sequence of operations.
5. Sequence Control element—controls the type of operations and the order in which they are to be performed.
6. Output mechanism—transfers results of computations to external memory.

A human computer, using pencil and paper, an abacus, or a desk-type calculating machine, performs one or more of the above functions. And even the fastest human computer is no match for an electronic machine. ENIAC, one of the first electronic computers with automatic sequencing (See CORNELL ENGINEER, Nov. 1947) was a significant development in speeding up the computing operation. But the "Electronic Numerical Integrator and Computer" used punched cards in its input-output and memory systems, and its sequencing was predetermined by the manner of plugging in connections. Here lay the major bottlenecks, for the electronic computing elements could work far faster than the information could be fed to them or received from them. Furthermore, the sequence control system was slow and inflexible.

**Supercomputer: The SEAC**

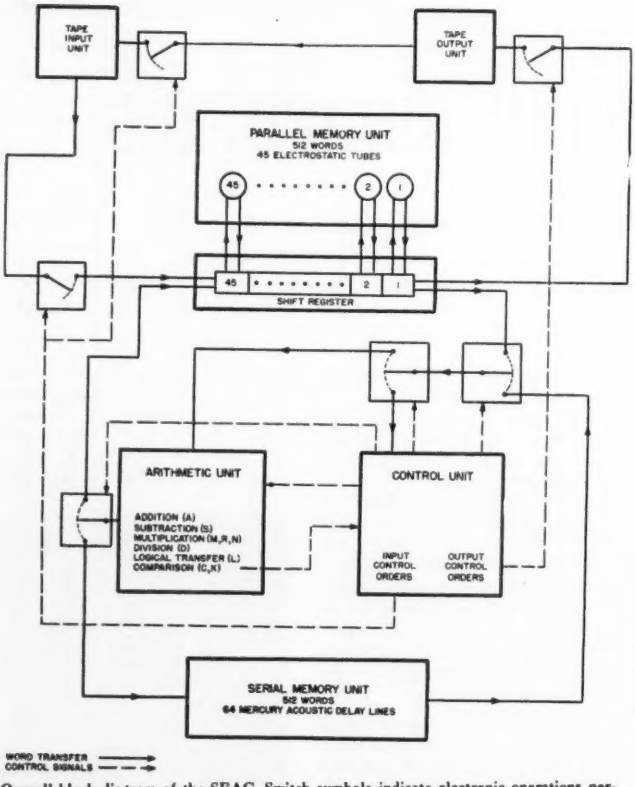
The newer SEAC incorporates many new innovations which eliminate to a large extent these bottlenecks. The rapid pulse rate (one megacycle a second) is made possible by the use of 12,800 germanium diodes instead of electronic tubes. The internal memory consists of ingenious acoustic delay lines, and it is planned to add later



View of the interior of the SEAC which gives some idea of its intricacy.

electrostatic storage tubes. These memories can store both numbers and instructions.

The fast and capacious acoustic delay lines operate by transmitting a train of sound waves down a mercury column. Electrical pulses fed into the input crystal transducer cause it to vibrate, and generate sound waves which travel down to the output crystal transducer at the other end at a velocity of about 5000 feet per second. In passing through the mercury, however, the pulses are distorted in shape, and a




**Overall block diagram of the SEAC. Switch symbols indicate electronic operations performed automatically under the duration of the machine's control unit. Switching times are about one micro-second.**

timing shift occurs after each circulation. This is caused by small errors in the temperature control system, thermal changes in length, and inaccuracy in construction. If the shape distortion were not corrected, the pulse groups would lose their identity after a few circulations, and it would be difficult to select a group of pulses from the several circulating in a single channel. Additional difficulties would arise in the arithmetic circuits, since timing synchronization is essential for proper operation, as will be explained later. Both timing shift and distortion are corrected by using the distorted pulses to "gate" pulses of standard shape. These gated impulses may then be fed back to the input of the delay line, and they will circulate through the delay line memory gating other pulses as many times as necessary without altering their original characteristics. SEAC has 64 acoustic delay lines, each capable of storing eight 45-digit words. It takes an average of only 168 microseconds to refer to a word in the memory.

Another type of memory is the electrostatic storage tube, which stores information in the form of dots on cathode ray tubes. Electron beams, scanning the surface in much the same way as a television tube, place and pick up the information in predetermined locations. Plans for the future expansion of SEAC call for the addition of a parallel system of 45 electrostatic tubes with an access time of only 12 microseconds.

A third type of memory system is utilized in General Electric's "Omibac" digital computer. Fast spinning cylinders coated with a black magnetic material store the information in the form of magnetic impressions on the surface.

### Binary Numerical System

While the ordinary decimal system is advantageous for counting on one's fingers (and toes if necessary), the binary system is more ideally suited to electronic computing machines. It is much more practical and economical to build an electronic computer using the two states, "on" and "off," to represent the digits 0 and 1. Any numerical quantity can be denoted with these two digits as illustrated in the following comparison with the decimal system.

| *Decimal* | *Binary* | *Decimal* | *Binary* |
|---|---|---|---|
| 0 | 0 | 9 | 1001 |
| 1 | 1 | 10 | 1010 |
| 2 | 10 | 11 | 1011 |
| 3 | 11 | 12 | 1100, |
| 4 | 100 | | etc. |
| 5 | 101 | | |

Arithmetical operations in the binary system follow the same rules as in the decimal system. At the risk of sounding like a grammar school teacher, let it be said that one apple plus one apple still gives only two apples in the binary system, even though the symbol is "10." In other words, the operation 1 + 1 still produces two, but instead of using the symbol "2" to express the result, a second place is added and only the digits 1 and 0 are needed to express the quantity. Binary arithmetic is actually quite simple, but children would probably have difficulty using their fingers to aid them, which is probably the reason ancient man adopted the decimal system rather than the binary. The following examples show how electronic computers do the same thing as human brains, but in a different and extremely rapid fashion.

| *Decimal System* | *Binary System* |
|---|---|
| 1 + 0 = 1 | 1 + 0 = 1 |
| 1 + 1 = 2 | 1 + 1 = 10 |
| 3 + 4 = 7 | 11 + 100 = 111 |
| 5 + 6 = 11 | 101 + 110 = 1011 |

Though the binary system requires a larger number of places to express the same quantity, it is still more economical than building a computer which would be able to indicate accurately a digit on the decimal scale of ten.

Binary numbers may be trans-

(*Continued on page 24*)

# News of the College

## DuPont Fellowships

Cornell is among 47 universities which have been awarded fellowships and grants-in-aid to encourage graduate research in chemistry and other fields. The funds provide support for pre-doctoral and post-doctoral training of students in these branches of science in institutions of higher learning.

The $10,000 grant-in-aid is for unrestricted use in the field of fundamental chemical research. Pre-doctoral fellowships in chemistry and chemical engineering will provide $1,400 for single persons or $2,100 for married persons, together with an award of $1,200 to the university. The post-doctoral fellowship in chemistry provides $3,500 for the recipient and a grant of $1,800 to the university.

Selection of candidates for fellowships and the choice of problems on which they are to work are left to the university. Individuals are under no obligation with respect to employment after accepting the fellowships.

## Chi Epsilon

Chi Epsilon, the civil engineering honor society, elected the following new members:

Forest E. Blair '51
Ralph M. Baumgarten '52
Walter S. Bortko '52
William A. Marson '52
John E. Newhard '52
Frank P. Robertson '52

## AIEE Lecture

At a joint meeting of the AIEE and IRE student branches, Mr. D. B. Smith of the Philco Corporation presented a talk entitled "The Color Television Problem."

Mr. Smith, vice-president in charge of research for Philco, pointed out the need of a compatible system with color television because of the huge investment in present black and white equipment. He then went into the technical aspects of several systems now being tried out by at least four large corporations, making clear the fact that the best system is yet to be decided upon. Mr. Smith also described the basis of the Philco system. The lecture was illustrated with slides of various experimental devices now being employed in color television.

Earlier in the evening a banquet was held by the AIEE in Willard Straight Hall in honor of the speaker.

**Walter A. Harrison, EP '52, receiving a $500 scholarship check from the Delta Upsilon Foundation. Presenting the check is Professor Lloyd P. Smith, Chairman of the Department of Engineering Physics.**
*—Courtesy Cornell Public Information Office*

## Harrison Wins D.U. Award

Walter A. Harrison, E.P. '53, has been awarded a $500 Delta Upsilon Foundation Scholarship in recognition of his leadership and outstanding scholastic achievement here at Cornell.

The award is one of six regional scholarships given annually by the educational foundation of Columbus, Ohio to upperclassmen in the United States and Canada. Harrison, whose scholarship is for the region including colleges in New York, New Jersey and Ontario, received the check and a certificate award at a meeting of the student society of Engineering Physics.

His activities include president of the junior class and a member of the Student Council. Academically, he ranks second in his class in engineering physics and has been on the dean's list for both of his years at Cornell. In addition, he also holds a University Undergraduate Scholarship.

## Machining Stress Research

Of vast importance to every branch of industry which employs a metal cutting process are the residual stresses induced in the surface of a piece of metal by the action of the cutting tool. Professor Erik K.

*(Concluded on page 26)*

Fred Jennings, Arts '52, and Robert Koftoff, EE '54, engineer a basketball game at Barton Hall.

# WVBR

Budding engineers, especially EE's, are put to immediate use by WVBR to keep its three transmitters humming, and its studio and portable broadcasting equipment in working order. As this Picture-Brief shows, the station gives students experience in every phase of radio broadcasting. Programs are beamed at the studio taste—near-complete coverage of Cornell sporting events and programs of popular and classical music, broadcast at times convenient to the student audience. WVBR is the only Eastern college station to give complete coverage of all home and away basketball games, and also broadcasts all home baseball games and many other sporting events.

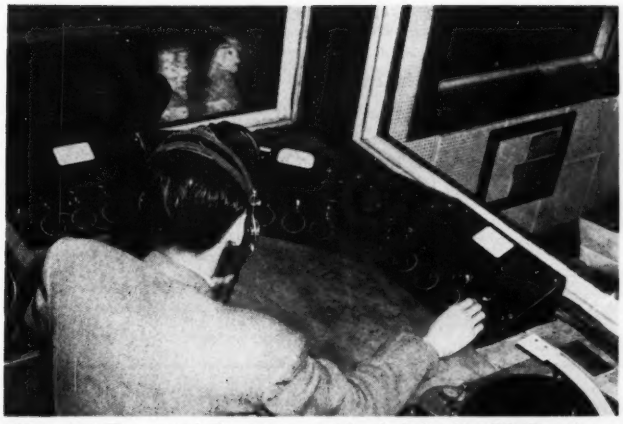
The station is entirely student-owned and operated. It is one of the two subsidiaries of the Cornell Radio Guild, Inc., the other being the Cornell Recording Service. Engineering students are employed in many capacities by the station—programming, announcing, writing—in addition to handling the technical details of radio broadcast operation.

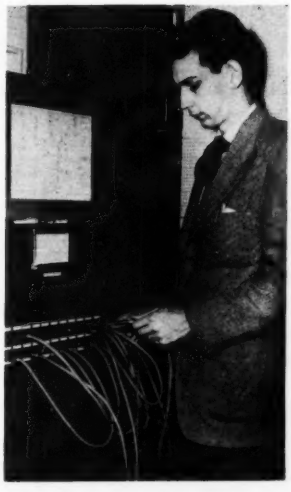
In addition to gaining valuable personal experience, the staff of WVBR is rendering a useful service to the entire campus community. The station is well-known as the only one in the area which is free of hillbilly music and soap operas, and as such is greatly appreciated by the more cosmopolitan student listeners. Experiments are presently underway to determine the optimum location of the transmitters to reach the largest number of students—they are now located in Balch, Willard Straight, and the Old Armory.

(*Left*) A program rehearsing in WVBR's Studio A. (*Right*) Larry Weingart, Arts '52, cutting a transcription using equipment of the Cornell Recording Service, WVBR's affiliate organization.

# The Voice of the Big Red

*Photographs by Robert Stuckleman, EE '54*





(*Above, left*) The custom-built master control board, designed by WVBR engineers. (*Above, right*) Paul E. Seidel, EE '54, "patching in" special broadcast circuits on WVBR's main jack field.

(*Below, left*) Robert Schuetz, EE '54, selects a record from one of the 3000 popular and classical selections in WVBR's record library. (*Below, right*) Eric Teddlie, ME '53, broadcasting the latest Associated Press news from Studio B.

# Cornell Society of Engineers

107 EAST 48TH STREET 1950-51 NEW YORK 17, N. Y.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*Honorary Vice Presidents*:
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N. A. Christensen, Director of the School of Civil Engineering
H. J. Loberg, Director of the Sibley School of Mechanical Engineering
F. H. Rhodes, Director of the School of Chemical and Metallurgical Engineering
W. R. Sears, Director of the Graduate School of Aeronautical Engineering
L. P. Smith, Director of the Department of Engineering Physics

George T. Minasian

*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."*

## *President's Message*

Those of us who have attended the meetings of the Cornell Society of Engineers in New York are most grateful to Dean Hollister and the Directors of the Engineering Schools for their visits with us. There is something stimulating in meeting personally the men who are directing the Engineering activities. Their stories are not confined to the factual presentation of modern curricula. They also tell us frankly of their troubles, and hopes for the future. We then have ample opportunity to ask questions.

I feel that these men are excellent ambassadors for Cornell. They are not the super salesman type, but their frank presentation and obviously sound grasp of the requirements of their respective jobs inspire confidence that Cornell Engineering is in good hands.

Having heard from the Engineering School Directors we hope during the Spring Vacation to hear directly from the Engineering undergraduates. We are asking them to put on their own program at a New York Meeting.

I always feel refreshed in body and spirit after a visit to Ithaca and the week end of the Yale game was certainly no exception. The changes are many of course. The Building Program is impressive, the Heights still grow, as do the trees cutting off some of the well remembered vistas. But most important there remains the beauty of the setting, the sunsets across the valley, the rugged gorges. The elms, on the old quadrangle, have not succumbed to the storms and the views of Ezra Cornell and Andrew D. White from their respective pedestals give a comfortable feeling of permanence. At the risk of being tabbed a sentimental old codger, I still insist, that the beauty of Ithaca plays a most important part in the life of a Cornell student. The fact that I have visited universities in every state in the Union only serves to strengthen this belief. If you haven't been back to Ithaca recently, by all means try it. I am sure it will do you good.

George T. Minasian

# Alumni News

**Arthur Adams, C.E. '01,** died October 22, 1950, following a stroke. He was formerly with J. G. White Engineering Co. of New York, and worked on projects in many parts of the world. He was a lieutenant colonel in the Ordnance Department of the Army. He lived at 281 Rugby Road, Brooklyn.

**Lesley Ashburner, C.E. '06,** retired Navy Department civil engineer, died at his home, 111 Del Ray Avenue, Bethesda, Maryland. He was engineer in the Washington, D.C. Navy Yard during World War I, then a builder in Los Angeles, for fourteen years. Returning in 1939 as a consulting engineer for the Army and Navy, he worked on the design of the Pentagon and other government buildings.

Four Cornell Alumni are members of the Fuller Construction Co., of New York City. They are: **J. D. Tuller, C.E. '09; Arvin J. Dillenbeck, C.E. '11,** Chief Engineer; **Clark E. Wallace, C.E. '27,** Project Manager for emergency water supply for New York City; and **C. Powell Beyland, C.E. '31.** Several years ago the Tuller Co. was called upon to rush the steel stands on the west side of Schoellkopf Field to completion before that year's Navy game, and did the difficult job on time.

**Walter S. Carpenter, Jr., M.E. '10,** has been easing up of late. He now takes a day off for some mountain climbing, on horseback, to see what's on the other side, not on the top.

He wasn't always so leisurely. When he left Cornell, he went to work for E. I. duPont De Nemours and Co. He stayed with them and became vice-president in 1919, president in 1940, and headed the firm until 1948. After that, he became Chairman of the Board. In 1945 he was awarded the John C. Jones Gold Medal "for distinguished service to the War Department."

With that background, he became director of General Motors' policy committee, the Chase National Bank of New York, Wilmington Trust Company, Diamond State Telephone Co., etc. With all these activities, he has managed to keep

**Walter S. Carpenter, Jr.**

up his contacts with the University. He was elected to the Board of Trustees, and was placed on the Finance Committee, to complete the term of J. duPratt White; after that he was elected for a full term. He served on the Greater Cornell Committee, and is now on the University Council.

He has three sons and an increasing number of grandchildren. His address is Eighteenth Street and Rising Sun Lane, Wilmington. His office is in the duPont Building.

**Henry Ten Haven, C.E. '13,** has been engineer in the New York State Department of Public Works for many years. He has been moved up to deputy chief engineer in the State Public Works Department, and will head the Division of Construction, Canals, Waterways and Flood Control. He is a member of a number of professional societies.

**G. P. Simmen, M.E. '21,** is a division superintendent of electrical distribution for Public Service Electric and Gas Corp. at Camden, New Jersey.

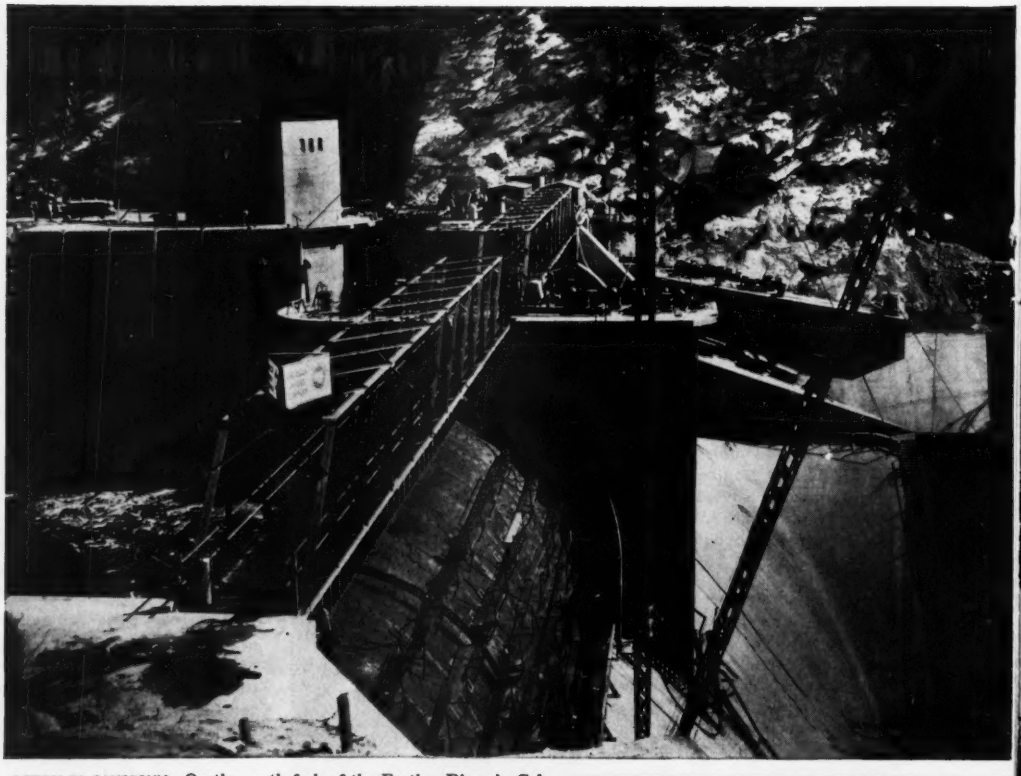
**Robert G. Clark, M.E. '22,** was elected a director of Utah Oil Refining Co., Salt Lake City, in April. He had been chief engineer for more than twenty-five years and was made refinery manager in October 1949.

**Phillips B. Hoyt, E.E. '27,** was promoted Sept. 1, from director of purchases to vice-president in charge of purchases for the American Car Foundry Co., in New York City.

**Austen W. Boyd, B.Chem.E. '43,** of the General Electric chemical department has been put in charge of the chemical process development group at Waterford. Boyd won the company's Coffin Award this year for his collaboration in the design, construction and testing of an improved reactor for producing silicones.

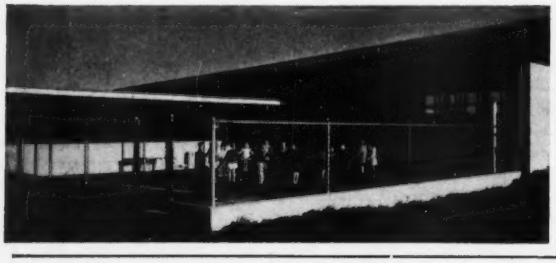
**John P. Gnaedinger, C.E. '46,** has been elected president of the Gnaedinger and Van Elst Labquip Corp., Chicago, Illinois, midwest distributors of testing apparatus for metals, concrete and other materials. He is also Secretary-Treasurer of Soil Testing Services, Inc., a Chicago firm specializing in soils engineering.

# Only STEEL can do so many jobs



**ACTION IN CALIFORNIA.** On the north fork of the Feather River in California, Pacific Gas and Electric Company has placed two new dams . . . Cresta Dam and Rock Creek Dam. The huge drum gates for these dams, and the bridges directly above them, required 4,380,000 pounds of steel. They were fabricated and erected by United States Steel.

**NEW SCHOOL HAS 2-WAY PROTECTION.** No matter how absorbed these children become, they can't rush into the path of passing traffic, because they are protected by sturdy, long-wearing Cyclone Fence. And the fence not only keeps the children inside, it keeps undesirables out.



**WASH DAY IS NO HEADACHE** in hospitals, hotels, restaurants, clubs, or laundries where equipment is made of U·S·S Stainless Steel. For stainless steel means easy cleaning, corrosion resistance, good looks and long life. Lucky that United States Steel is big enough to turn out steel for washing machines as well as warships, for toasters as well as tanks.

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# so well...

**TOUGH ON TANKS.** The steel rocket fired by this new 3.5 inch "superbazooka" has already proved itself an effective anti-tank weapon. It weighs nine pounds, is able to penetrate up to 11 inches of armor. Although mobilization will require increasing amounts of steel, the constantly-expanding steel-producing facilities of U. S. Steel should enable it to make plenty of steel for essential peacetime uses, too.

**FACTS YOU SHOULD KNOW ABOUT STEEL**

American steel mills can out-produce the rest of the world combined by 13 million tons of steel a year. The plants of United States Steel alone are pouring more steel than all the Communist nations put together.

**NEW LIGHT ASSAULT TRANSPORT.** Six rocket units help to lift the 40,000-pound weight of this new U. S. Air Force light assault transport in a recent test flight. With the addition of rocket units, the three-engine plane can now transport heavy loads in and out of small clearings. Only steel can do so many jobs so well.

**Listen to . . . The Theatre Guild on the Air,** presented every Sunday evening by United States Steel. National Broadcasting Company, coast-to-coast network. Consult your newspaper for time and station.

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# Techni-Briefs

## Radiation Monitor

A new atomic radiation detector to permit direct radiation readings at a glance has been developed by engineers of the General Electric Company.

Called a "radiation monitor," the new instrument weighs less than a pound and is about the size of a quart oil can. It is equipped with a self-contained power source, and has neither tubes nor batteries.

Radiation measurements are read from the monitor simply by noting the position of a pointer as it moves across a graded scale. The speed at which the pointer moves across the scale is in proportion to the strength of radiation, and the distance it moves in a given time indicates the amount of radiation to which the instrument has been exposed during that time.

The monitor is for use by engineers, scientists, doctors, and technicians who are working with or near sources of radiation, and can warn of the presence of radiation in amounts much less than those permitted by even the most stringent safety regulations.

This sensitivity, coupled with a continuously-visible indication, will give warning of a radiation hazard in an area while there is still time to avoid excessive exposure. This differs from the type of monitor that is read only at intervals, when it may already be too late to prevent an overdosage.

## Cornell-Designed Cleat

A radical improvement has been incorporated into football shoes developed by the Cornell Aeronautical Laboratory for MacGregor Goldsmith, athletic equipment manufacturers. The improvement consists of a ring cleat, which is placed on the sole of the shoe directly beneath the ball of the foot. An additional cleat of circular arc form is placed on both the toe and heel of the shoe.

These cleats, according to extensive tests, give equal or more traction than afforded by seven conical cleats now in common use on football shoes, and will insure the player of better getaway, greater maneuverability, and surer stops.

In addition, it has been found in actual practice that injuries to ankles and knees are greatly reduced.

**New football shoe designed by the Cornell Aeronautical Laboratory.**
*—Courtesy Cornell Public Information Office*

Both the construction and the location of the new cleats contribute directly to their effectiveness. They are made of light-weight aluminum alloy.

The ring cleat, being directly beneath the ball of the foot, provides a broad platform of stability and offers good traction over this area —on which most of the body weight is carried in any forward motion. The shape and position of the cleat offer the least resistance to rotation—enabling a player to turn, cut and maneuver with much greater ease, and less chance of twisting an ankle or knee than ever before.

The toe and heel cleats also assist in sudden maneuvers, since both cleats are arc-shaped, with the center of curvature at the center of the ring cleat. This engineering principle provides an axis rotation through the ball of the foot.

To reduce any clogging tendency within the ring, the cleat is so designed that any clod which might be formed would be the thinnest at the center, and therefore weakest at the section where it would receive the bending necessary to break it loose. Also, the inside surfaces of the ring are sloped to crowd the dirt towards the center of the ring, thus causing it to buckle outward when pressure on the foot is released.

It is well known from the injury records of football players that there are a large number of ankle, knee and hip injuries. A detailed analysis of these disclosed that a high percentage of injuries is the result of twisting forces on the leg, induced by the traction cleat commonly used on the soles of the shoes.

It was also found that many of the common traction cleats, when made long enough to provide satisfactory traction on soft ground, increased the incidence of ankle injuries when used on hard surfaces. The raising of the ankle joint increased the lever arm of the forces, causing ankles to turn. Also, it was found that in certain soils the common cleat arrangement picks up a clod between the cleats, thereby reducing the traction almost to zero for the next step. Injuries caused by slips and falls result.

## Homemade Cloud Chamber

A cloud chamber of improved usefulness to atomic research, but simple enough to be built at home has been described by four scientists from Brookhaven National Laboratory.

Present cloud chambers permit observation of the paths of cosmic rays and other atomic particles only

*(Concluded on page 26)*

# *We squeezed first . . . and*

NOW IT'S YOUR TURN. Pick up one of those new pliant, unbreakable plastic bottles. Squeeze it. Feel how it gives under your hand, then see how it comes right back for more.

That's polyethylene (just say POLLY-ETHEL-EEN), one of the exciting new miracle plastics produced by the people of Union Carbide.

But before you squeezed it, they squeezed ethylene gas under terrific pressure and carefully controlled conditions. Result: the molecules of gas were *permanently* rearranged into long lines—one of the marvels of modern chemistry. And then out came this tough, flexible plastic utterly unlike any other material—natural or man-made.

Why do you find the people of Union Carbide leading in the development of polyethylene?

Because working with tremendous pressures, high vacuum and extremes of heat and cold is part of their everyday jobs. By the use and control of these forces they supply the world with a wide variety of plastics and the raw materials from which a multitude of synthetic fibres are made. They also make hundreds of other basic materials essential to modern science and industry.

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## Electronic Computers

(*Continued from page* 14)

mitted in two ways, serially or in parallel. In serial transmission, all the pulses are transmitted on a single wire and the place is determined entirely on a temporal basis. Since the pulses are passing through the computer at a fixed frequency, the presence or absence of a pulse at each cycle indicates whether the digit is one or zero. This explains the need for maintaining synchronization in the acoustic delay lines. In parallel transmission, as many lines as places in the binary number are necessary, and the representation is mainly spatial. The diagram below shows the binary number 101101 transmitted by both methods.

### SEAC Operation

In the serial operation of a computer, a composite group of fixed length is known as a "word." In the SEAC a word contains 45 pulse positions which are transmitted between units in a serial manner. The words may be used to communicate either a number or an order.

One order word is sufficient to find the two numbers to be operated upon, commanding the right operating to be performed, giving the the address of the result, and the address of the next order. (The address is a code number which tells the computer where the number or order may be found, and in which memory.) Thus, the operation of the computer is entirely automatic.

### Problem-Solving

SEAC has seven basic operation orders, chosen after a careful study which established their convenience for solving the most elaborate problems the machine is expected to handle: addition, subtraction, multiplication, divison, comparison, logical transfer, and input-output control. All arithmetical operations can be classified as types of addition, since the sign of a number need be merely reversed to perform subtraction, while multiplication and division are just a series of additions or subtractions. One operation of addition or subtraction is completed in 50 microseconds; multiplication and division in 2500 microseconds.

The comparison order allows two numbers to be compared to determine which is larger. This feature gives the machine a degree of choice. The result of a comparison thus dictates which of two alternative operational sequences the machine is to perform next. The logical transfer order makes it possible for the machine to alter an instruction it has previously received.

At present SEAC's input-output can be accomplished either with manual keyboard and teletype printers, or punched tape. It is planned later to install a magnetic wire system to replace the present punched tape input-output system, speeding operations about 160 times. Magnetic wire is compact, durable, and erasable, but has the objection that one cannot tell, just by looking at it, whether anything has been written on it or not.

Contrary to some wishful think-

(*Concluded on page* 28)

for temperature, pressure,
liquid level control . . .
Choose Klipfel valves
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#349—Float Valves
For dependability and economy . . . whether for plant equipment or manufactured products . . . specify Klipfel Valves . . . a wide range of standard types, as illustrated below, or controls designed specifically for you. If you have a control problem, discuss it with Klipfel Engineers. Write for the latest Klipfel Valve bulletins shown here, each contains valuable, easy-to-use selection and specifying data. Address Dept. L-2.
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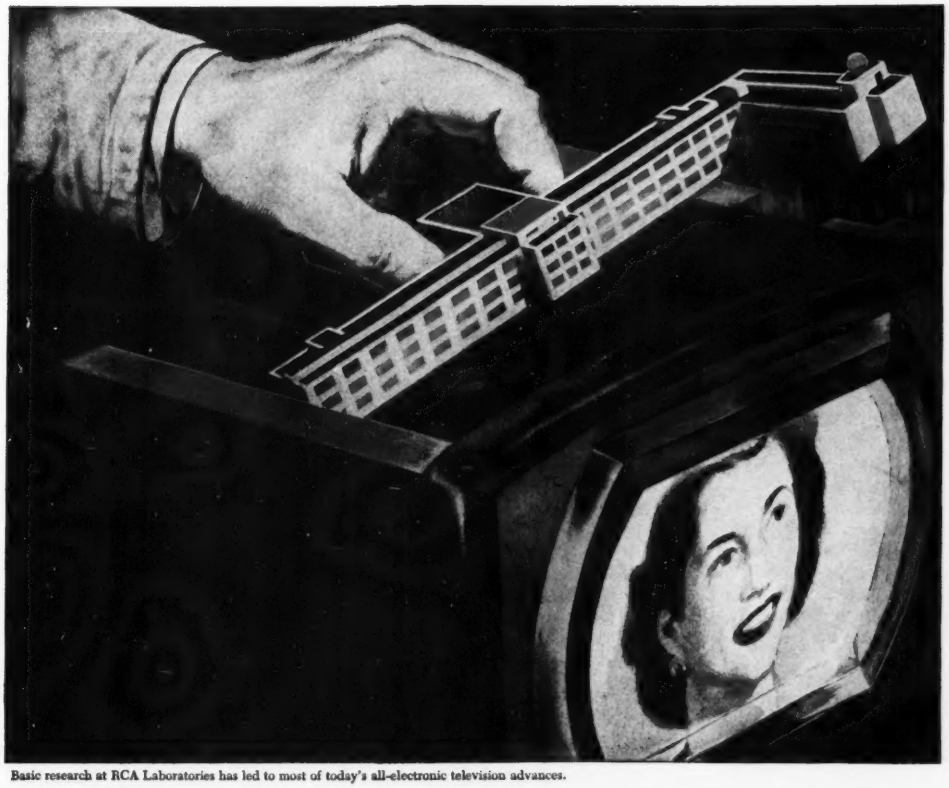
DIVISION OF HAMILTON-THOMAS CORPORATION, HAMILTON, OHIO



Basic research at RCA Laboratories has led to most of today's all-electronic television advances.

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The image orthicon television camera was brought to present perfection at RCA Laboratories. The kinescope, in these laboratories, became the mass-produced electron tube on the face of which you see television pictures. New sound systems, microphones—even the phosphors which light your TV screen—first reached practical perfection here.

**Most important of all, the great bulk of these advances have been made available to the television industry. If you've ever seen a television picture, you've seen RCA Laboratories at work.**

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*See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.*

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**Graduate Electrical Engineers:** RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
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**Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

**RADIO CORPORATION of AMERICA**
*World Leader in Radio—First in Television*

## Techni-Briefs

(*Continued from page 22*)

intermittently, for fractions of a second. Now, by simple methods, a cloud chamber can be built to permit observation continuously for hours.

To operate any cloud chamber, the experimenter makes a saturated atmosphere. Atomic particles themselves are much too small to see. But as they dart through this atmosphere in the chamber, they leave a trail of small droplets which are clearly visible—like the vapor trail left by high flying aircraft. Heretofore in cloud chambers, the "cloud" has been made by a complicated mechanical expansion of a space holding a vapor, so that tracks suddenly appear for a very brief interval.

In the new continuous chamber the vapor diffuses continuously from a warm upper surface to a cold lower one through air or another gas. At some point between the two surfaces, the diffused vapor will become sufficiently cool to produce supersaturation. Because vapor is continually diffusing, the chamber will show tracks continuously. This continutiy of operation assures scientists of obtaining in a short time, and without interruption, many photos of interactions of atomic particles.

The device, therefore, is particularly useful in studying interactions caused by beams of particles from cyclotrons and other high energy machines. Also, since it is simple to make and operate without interruption, it is useful in the classroom.

The essential ingredients are easily obtainable and readily assembled. Dry ice is placed in a flat container underneath a metal disk 5 to 17 inches in diameter. On the top surface of this disk is placed black velvet, to provide a background for viewing the paths the particles make. A glass cylinder, slightly smaller in diameter, and lacking top and bottom, is placed on this disk. Felt soaked in methyl alcohol is fastened to the lower side of another metal disk which is then placed on the top of the glass cylinder. A tray of water at room temperature is placed on top of the upper disk.

When a strong light, such as a powerful flashlight, is focussed on the velvet, the chamber becomes a "showcase" for atomic events of many sorts. For example, the paths made by cosmic rays, which constantly bombard the earth from the outer atmosphere, will be continuously displayed.

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## College News

(*Continued from page 15*)

Henriksen, head of the Materials Processing Department, has been studying the nature of these stresses for the past 18 years.

The research that Professor Henriksen began in Denmark 18 years ago and continued here at Cornell has been accomplished with the aid of standard workshop equipment using relatively simple methods. The fundamental principle for the method employed is the lengthwise machining of a specimen which has been thoroughly annealed and very slowly cooled in the furnace beforehand to ensure complete absence of any other stresses. Usually, specimens of rectangular cross section are used and the machining done by planing or shaping. A cut is taken in the specimen and the resulting deformation of the metal is measured from which the value of the stress can be computed.

It has been found that in ductile materials such as carbon steel the stresses are generally tensile, while in cast iron they are compressive. Another fact revealed is that the stresses are closely related to the work-hardening properties of the material and, are more a function of the mechanical action of the tool than the thermal effect of the cutting as was previously thought.

Professor Henriksen is also studying other phenomena associated with metal cutting. The Materials Processing Department recently acquired a specially designed lathe with which he will investigate the effects of high speed cutting on alloy steels. With this new lathe it will be possible to determine the relationship between the speed and various forces which come in to play during the cutting operation. This will reveal the dangerous operating speeds.


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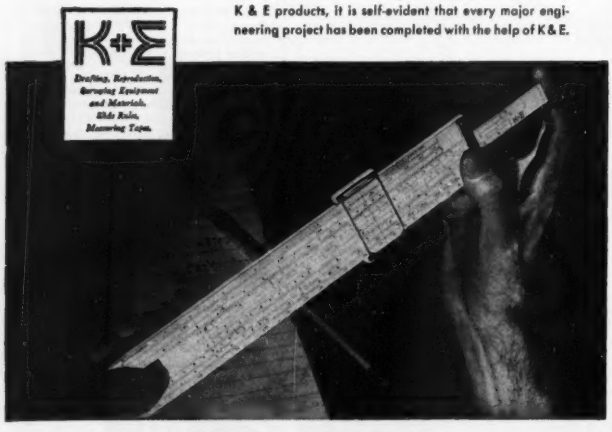


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These fast-moving times might well go down in history as the "Age of Transportation" . . . Today, people are able to enjoy goods delivered from places once wholly inaccessible. It is easy to visit friends many miles away. Doctors quickly reach the sick; country children enjoy the benefits of bigger schools in distant cities; industry is constantly expanding to supply you with more goods in less time—all through modern transportation by land, sea and air.

All this has been made possible largely by the rapid development of the internal combustion engine — powered and lubricated with petroleum products. Esso Standard Oil Company is proud of the part its 27,000 employees have played in producing better petroleum products for better transportation. And our regular good jobs policy—with fair pay, a chance to get ahead in the Company and many employee benefits—has helped us to get *good* people on the job.

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Right: Ice-making Tanks

Big Plant at Nampa, Idaho, Makes 500 Tons of Ice a Day with Frick Refrigeration

And quick-freezes 5 tons of fresh foods per hour at another plant, 600 feet away! Five cold storage rooms hold 2500 tons of ice and 85 carloads of frozen foods.

Seven large Frick ammonia compressors carry the cooling load. They were selected for this Terminal Ice and Cold Storage Co. plant by the Associated Refrigerating Engineers, Los Angeles consultants.

You can specify Frick refrigerating, ice-making and air conditioning equipment with confidence.

*The Frick Graduate Training Course in Refrigeration and Air Conditioning, Operated over 30 Years, Offers a Career in a Growing Industry.*

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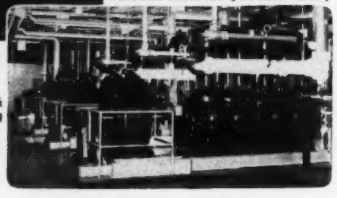
Also Builders of Power Farming and Sawmill Machinery

Above: Air View of Plant

Right: 5 of 7 Frick Compressors, Totaling 1600 Horsepower



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## Electronic Computers

(*Continued from page 24*)

ing among the non-mathematically inclined, a problem cannot be thrown into a hopper, a button pushed, and the answer pulled out. Breaking down the problem into simpler component calculations still must be done by highly skilled mathematicians, and the machine must be coded with the proper instructions. But once the machine has been programmed for a certain type problem, it can be used over and over again with different sets of numerical data. Moreover, the instructions can be altered or new ones fed into the input without rewiring or reswitching.

### Practical Applications

SEAC has already solved several significant problems such as computing the direction and position of skew rays in an optical system with several spherical lenses, and computing the flow of heat in a chemically reactive material. In the immediate future, the computer will be used to determine optimum programs in military scheduling for the Department of the Air Force.

The range and scope of problems that can be solved with modern automatic computing machines is unlimited. In fact, they are not even limited to computing problems, but could be extended to any type of substitution problem that could be solved with a limited number of rules. The input data, instead of being numbers, could be the readings of strain and pressure gages, photo-electric cells, etc. Since the machine has the ability to choose between two or more alternative instructions, it could make logical decisions. This suggests many possibilities for automatic assembly lines with computing machines to supervise them.

In his noted book, *Cybernetics,* Professor Norbert Wiener points out the similarity between the computing machine and the human brain. There is a very definite anology between the "on" and "off" firing of an electronic system and the firing of a neuron, an element of the nervous system. Furthermore, there is some reason to believe that the human memory operates in the same manner as an acoustic delay line, i.e., circulating impulses trigger off standard shape impulses which circulate again, and so on. Professor Wiener further suggests that cases of malignant worry are analogous to an internal memory system in which the message keeps circulating, enveloping more and more channels or neurons as it contains.

### Machines That Think?

Just as man has succeeded in developing machines which far outstrip the human muscle in power and dexterity for specialized purposes, so it seems now that the human brain has been relegated to a secondary position in speed of performing certain repetitive mental tasks. The ditch digger can no longer compete with the steam shovel. Will the day come when "thinking machines" usurp man's supreme position in the nebulous area of thought?

# *Newsworthy Notes for Engineers*

GRID FRAME
*(actual size)*

## A touch of gold... a lot of Engineering!

**This is the grid frame** for an electron tube that plays a vital part in the Bell System's radio relay network for long distance telephone calls and television programs.

**Across the central hole** of a frame—between dotted lines—tungsten wires .0003 of an inch in diameter, so fine you can barely see them, must be placed with their centers .001 of an inch apart. How to fasten this wire securely to a frame posed a problem that took the combined skills of many kinds of engineers.

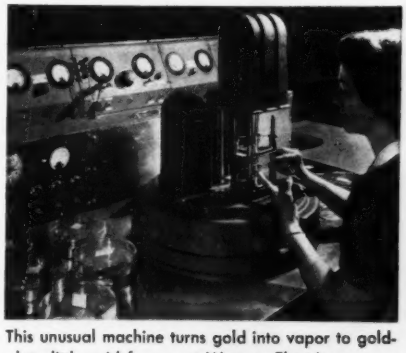
**Electrical, Chemical and Metallurgical** Engineers decided it could best be anchored with gold. Why gold? Because it is inert in a vacuum, reduces grid emission, is suitable for the working temperature of the tube and is a good electrical conductor.

**Physicists, Electrical and Mechanical** Engineers tackled this problem — and adapted the machine shown, in which frames are placed—forty at a time—on a two-level rack. Between the uprights of the rack are heating coils into which short lengths of 24 karat gold wire are placed. An air-tight cover is lowered, the chamber evacuated and heaters are switched on. When vacuum and temperature are just right, the operator passes a carefully controlled current through the coils and the gold vaporizes, covering the grid frames with a coating .00002 of an inch thick. Only about two and one-half cents worth of gold per frame is used.

**Tungsten wire** is next wound around two frames at a time. These are put into a hydrogen atmosphere and heated until the gold melts and brazes the wire firmly to both frames, which are then split apart.

**Industrial Engineers** made thorough job cost and time studies which show this new process is fast and economical.

**Working closely together,** Western Electric engineers of varied skills are constantly developing new, better and more economical ways to make telephone equipment. That's how they help the Bell System give this country the best telephone service on earth at the lowest possible cost.



This unusual machine turns gold into vapor to gold-plate little grid frames at Western Electric.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

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Begin your career by doing what the masters do . . . use CASTELL with the famous imported graphite. It costs no more than ordinary domestic brands.
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## Ring Out, Ye Bells

(*Continued from page* 12)

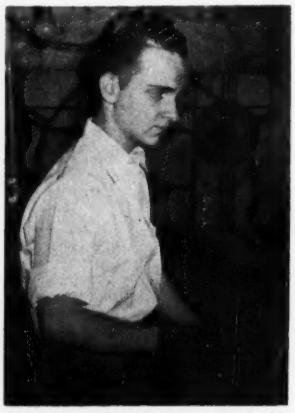
bells. Actually, automatic playing systems have been in use for more than 100 years, but are generally regarded as unsatisfactory because the carilloneur cannot put any expression into his playing. Shading and other forms of musical interpretation are hindered, rather than aided, by such equipment. By no means, however, does this statement imply that Cornell's playing mechanism is ideal. Playing a modern carillon with the conventional clavier linked by cables to the bells is facilitated by the fact that the mechanism is light, the heavier clappers are counterweighted, all of the clappers move only a short distance in striking, and every possible mechanical refinement that does not destroy the touch of the instrument is employed. At Cornell, the heavy mechanism of cables and chains indeed places a premium on general gymnastic ability and a handicap on musicianship, but is nevertheless preferable to any device which would take the opportunity of expression away from the chimesmaster.

### Popularity Increasing

During the past thirty years, carillons have increased rapidly in number in the United States. This sudden popularity can be attributed to modern developments in bell founding and tuning, as well as to the enthusiasm of Americans who visited and heard good instruments in Europe after World War I. Many of the 53 instruments built in the United States since 1920 have been placed in prominent universities and colleges, including the University of Michigan, Wellesley College, Leland Stanford University, Duke University, and many others.

One of the most notable carillons in the United States is the instrument of 49 bells at Princeton University. Originally it was of 35 bells cast by Gillett and Johnston of Croydon, England. These are of excellent tone and are examples of the finest in the bell-founders' art. When, in 1941, a complete renovation of the carillon was begun, additional bells could not be purchased. The fourteen bells added at that time were truly a product of the university, having been designed, cast, and tuned on the campus by Arthur L. Bigelow, professor of engineering and university carilloneur at Princeton. Professor Bigelow, having spent eleven years in Europe studying the technical aspects of bells as well as carillon playing, has established a reputation as a consultant and designer in his field.

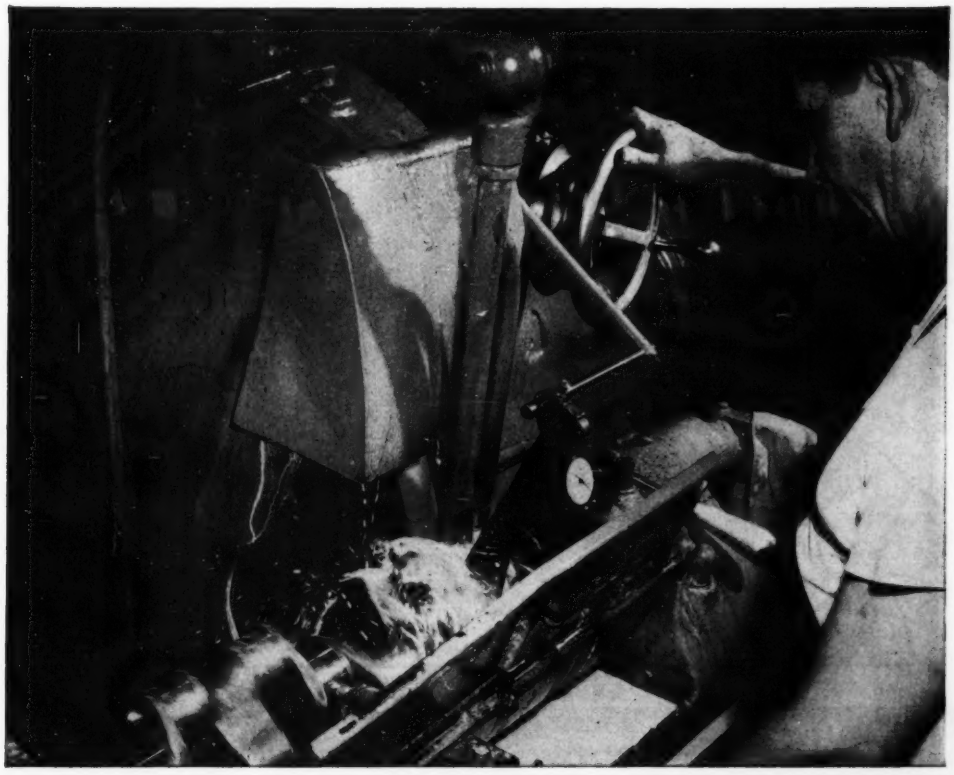
Several years ago, Professor Bigelow inspected and tested the Cornell Chimes are prepared plans for recasting the present bells, making



**Chimesmaster Gottling (author of this article) shown rendering a selection on the Cornell Chimes.**

31 new bells, and strengthening the tower to accommodate what would then be the fourteenth instrument of four octaves or more in the United States. A carillon of this calibre would provide facilities for a repertoire not limited to folk songs and other simple melodies, and for musical effects created through extensive arpeggios which cannot be produced by smaller instruments. While the present chimes have attained a place high among those things which make Cornell, and are both a novelty and an old tradition, a real carillon, whether a complete instrument of four octaves or somewhat less, would be a magnificent instrument as much capable of producing fine music as a pipe organ or piano.

Unfortunately, money with which to execute Professor Bigelow's plans is not at present available. Until the time when it is, the familiar bronze voice of the present bells will continue to add their part to the campus scene at Cornell.



## If a belt could do it better...

Grinding a crankshaft calls for a grinding wheel of definite specifications. But, if it could be done better, faster or more economically...with an abrasive belt, for instance... CARBORUNDUM would be free to recommend the *right* belt impartially. This is because only CARBORUNDUM manufactures a *complete* line of abrasives—and only CARBORUNDUM can make impartial recommendation of the *right* abrasive to use in every grinding or cutting operation.

In addition to abrasives, many other products of equal importance industrially are identified by the CARBORUNDUM brand. Refractories are among the more important. So closely associated with outstanding characteristics and properties are these products, that "Super" has been added as a prefix to segregate them from the ordinary. In the fields of heat treatment and ceramics, GLOBAR non-metallic heating elements are used increasingly while ceramic resistors find application in an expanding list of electronic developments. The Canadian market is supplied by our large modern plant located in Niagara Falls, Canada just across the border from our principal manufacturing facilities.

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"keeps a finger" on belt tension

This compact, modern drive controls belt tension continuously; keeping it even, despite changes in load.

In fact, this drive keeps belt pull uniform two ways, *around* and *across* the pulleys. Here's how it works.

**1.** The tension-controlling motor base maintains uniform pulling power *around* the pulleys by automatically compensating for load changes.

**2.** The flat leather belt keeps belt pull uniform *across* the pulleys because it is undivided. No danger of separate, uneven tensions.

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A. Beyond the initial price, any engineer must consider: (1) the cost of installation, (2) the expense of maintenance, (3) the loss of revenue or production when cable fails and (4) eventual replacement cost. High quality Okonite cables seldom show a lower purchase price, but their proved reliability and long life make them the most economical cables when all costs are considered.

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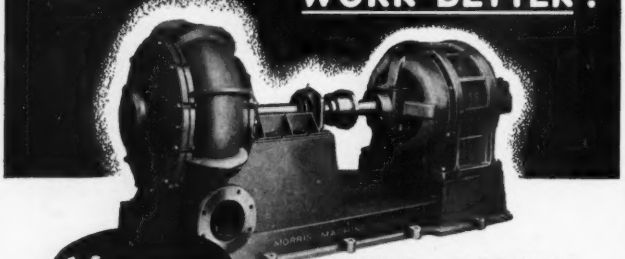

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MORRIS CENTRIFUGAL PUMPS

## Future of Atomic Power

(*Continued from page 9*)

tions. The slow-neutron plant will be similar to present reactors, but the intermediate reactor may be smaller and more compact.

The aircraft industry is now in a rather ambiguous position as to the possibility of using atomic energy. In 1948, an MIT committee investgiated the situation; the resulting Lexington Report stated that research on the aircraft problem should be continued intensively for two or three years, and that it would then be possible to make a decision as to the value of atomic energy for aircraft. The Fairchild Engine and Aircraft Corporation has done much work at Oak Ridge in spite of a small staff and a low priority budget of $10,000,000 per year. Considerable progress has been made, and the program appears more quickly attainable and less expensive than it did a few years ago. However, even though military pressure is for, rather than against, the program, the fact remains that NEPA (Nuclear Energy for the Propulsion of Aircraft) is a long-range project, and, as such, cannot be given high priority.

### Atomic Possibilities

The University of Chicago's Cowles Commission for Research in Economics recently reported on the possibilities of atomic power. With the assumption that engineers would successfully convert atomic energy to electricity and that physicists would perfect the breeder reactor, it was stated that the first atomic power stations would generate electricity at a cost of 10.2 mills per kwh, and that larger, improved plants might bring the cost down to four mills (based on 1946 prices). The commission predicted that atomic power might result in the future expansion of aluminum output by location of power plants near markets; the release of iron and steel-making from its slavery to coal; and perhaps the heating of homes in large cities by piping heat from a central atomic plant. It was decided that atomic power would probably not greatly reduce

(*Concluded on page 36*)

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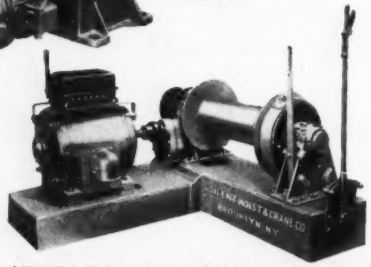

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## Future of Atomic Power

(*Continued from page* 34)

the cost of glass manufacture except where conventional fuels are relatively expensive, and that atomic engines for locomotives would probably never be practical except where traffic is heavy. The report stated that areas poor in conventional power might benefit greatly from atomic power; India and Brazil, for example, both import great amounts of coal, yet have most of the world's thorium.

### How Far Off?

Many scientists such as Harold Urey have found fault with the monopolistic government control of atomic energy, which they feel is stifling initiative and crippling their efforts. David E. Lilienthal advocates eventually turning over to private industry the information necessary for the experimentation and development of atomic power. He feels that the competition now forbidden would stimulate work and that private investment and the pioneering spirit which is a part of American industry would speed the development of atomic power.

Atomic power now looks far off, but it is actually closer than ever. Such authorities as Dr. Arthur H. Compton state that we may not have atomic power for 25 or 50 years, and Bruce R. Prentice of G.E. declares that there is "no assurance we will *ever* have atomic power." However, while it is true that lowering of costs and increase in power by use of atomic energy may be somewhat dubious, it promises many new things. From the standpoint of convenience and practical considerations other than costs, atomic power may compete with premium fuels for restricted use in the near future. In ship propulsion the freight capacity taken up by conventional fuel and the independence of refueling bases would be worth the cost of atomic power. Use of atomic energy for this purpose may do much toward the solution of technical problems arising in other applications of atomic power. Such problems as the weight of shielding material, which look insoluble for autos and locomotives and almost impossible for aircraft, may someday be eliminated, and in a few decades we may have the convenience of weightless atomic fuel in ships, planes, and locomotives which will run for months or years without refueling.

### Tremendous Potentialities

Knowledge of atomic energy has been accumulating for almost a half century; the solution of the many problems confronting us will be difficult and in many cases impossible. Nevertheless, the fact remains that in the long run the implications of atomic power for war and peace are tremendous. The AEC is not spending $40,000,000 a year for nothing. As Lilienthal says, "If the country means business, it won't take too long." Industrial know-how, if given the chance, can get the bugs out, and before long our "incredibly compact storage battery" may be doing useful work for us.

THE DU PONT DIGEST

# Bringing Up Alathon*

**Du Pont scientists find great promise in this young member of the wax family**

One of the most interesting and versatile of the new plastics is Du Pont "Alathon" polythene resin, chemical cousin of paraffin.

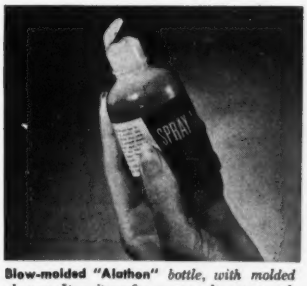
Because of its unusual combination of properties, it is now being used in everything from "squeeze-bottles" for toiletries to cable insulation and chemical-resistant linings.

"Alathon" was born when English scientists used high-pressure synthesis to create polythene, the solid and semi-solid polymers of ethylene. In 1939, Du Pont scientists and others added their background in high pressure work to the field of ethylene polymers. This concerted effort produced a greatly expanded range of uses.

## Taking First Steps

The first step of Du Pont chemists and engineers was to produce polythene in the laboratory to confirm earlier findings. Then the product was turned over to chemical engineers for pilot-plant work. Finally, a plant for full-scale commercial production was designed by chemical, mechanical and electrical engineers and metallurgists.

Many of the most promising uses for "Alathon" could not be realized until technical difficulties were overcome. For example, the chemical inertness, which is one of the outstanding properties of the material in film form, also made the casting of film from solution impractical because it could not be dissolved in suitable solvents. In devising a special extrusion technique to solve this problem, Du Pont engineers opened up a whole new field of possibilities.




**Blow-molded "Alathon"** *bottle, with molded closure. It emits a fine spray when squeezed.*

**Multiwall bags** *for chemicals and foods are made of kraft paper coated with "Alathon."*

## Acid-Defying Paper

In film form, "Alathon" lends its strength, chemical inertness and resistance to grease and moisture to packages for chemicals, foods, metal parts and moisture-sensitive powders. In still another form in which these properties are employed, paper coated with "Alathon" is used as wrapping for bakery products and moistureproof containers for chemicals that would attack uncoated paper. (Experimentally, "Alathon" coated paper has been exposed to concentrated sulfuric acid for days without harm; the same paper, uncoated, was ruined within a few minutes.)

The protection of "Alathon" was extended to metal tanks and drums when Du Pont engineers developed a spray-flaming coating technique.

In the field of electricity, too, "Alathon" is proving of great value. Its outstanding electrical properties make it an ideal insulator for wire and cable, particularly in the high-frequency applications necessary in television and radar.

**All "Alathon"**—*ice-cube trays, refrigerator bowls, tableware and protective coverings.*

**Pipe** *made of "Alathon" is used for handling corrosive chemicals, solutions and gases.*

"Alathon" in powder form is used for molding a wide range of light, tough and flexible plastic articles. In addition to bottles, these include tumblers, dishes, jar caps and ice-cube trays. Extruded as a film, it serves for garment covers, tablecloths and rainwear.

The future looks bright for "Alathon." New applications such as extruded pipe for mines and separators for storage batteries seem about to be realized. Other uses yet undreamed of will no doubt emerge from the close, continuous teamwork of technical men that typifies Du Pont research.

*REG. U. S. PAT. OFF.

**DID YOU KNOW . . .**

six out of ten Du Pont plant managers and superintendents started with the company as chemists, analysts, technicians or engineers.

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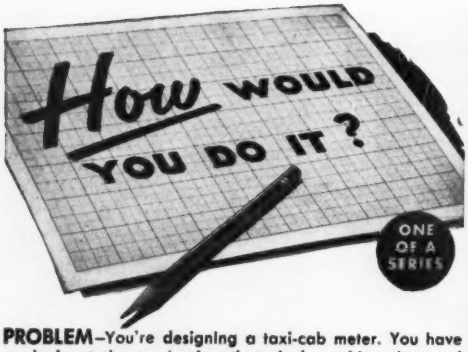


**PROBLEM**—You're designing a taxi-cab meter. You have worked out the mechanism that clocks waiting time and mileage and totals the charges. Your problem now is to provide a drive for the meter from some operating part of the cab—bearing in mind that the meter must be located where the driver can read it and work the flag. How would you do it?

**THE SIMPLE ANSWER**—Use an S.S.White power drive flexible shaft. Connect one end to a take-off on the transmission and the other to the meter. It's as simple as that—a single mechanical element that is easy to install and will operate dependably regardless of vibration and tough usage. That's the way a leading taximeter manufacturer does it as shown below.

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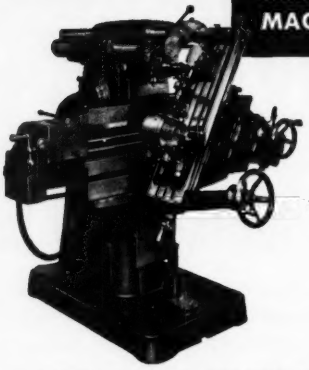

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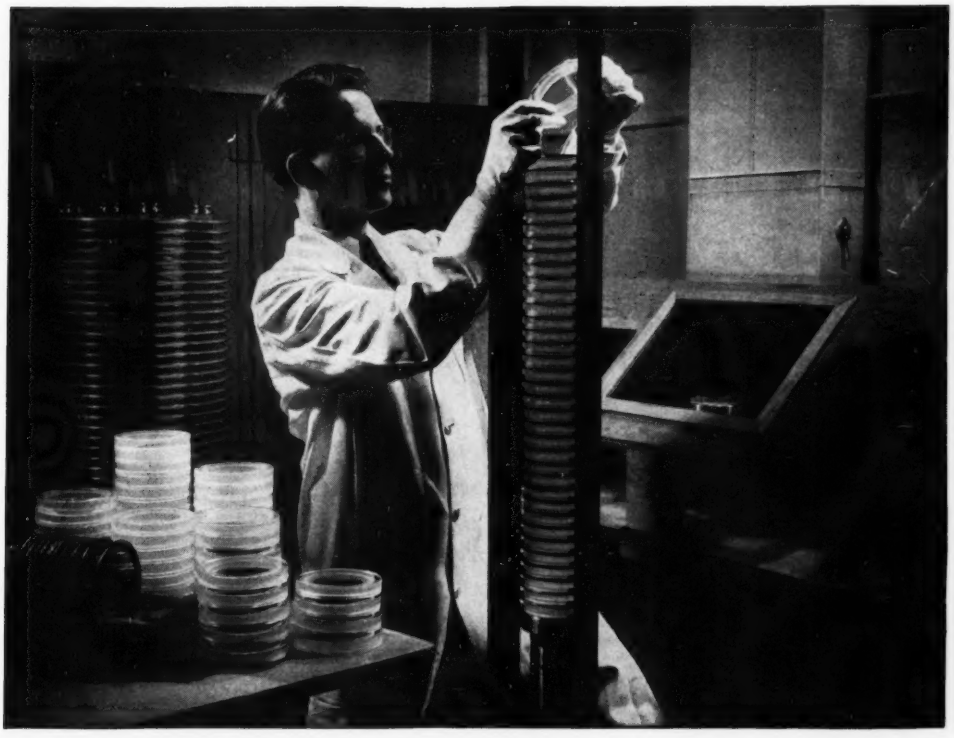


# A gun barrel made of glass . . .

**This scientist** is putting together the barrel of an "electron gun." When completed, it will be capable of developing cancer-killing rays at twice the power of those given off by all the medical radium in the world.

The barrel of the gun, part of a new super-voltage X-ray machine used in cancer research and treatment, is a tube formed by stacking precision-made rings of one of Corning's special electrical glasses.

Two million volts drive electrons through the tube, much as a bullet is driven through a gun barrel. As these electrons are suddenly stopped by a water-cooled block of gold at the end of the barrel, two-million-volt X-rays are generated. This X-ray beam is powerful enough to reach diseased areas four inches inside the body and it can be directed with great accuracy on the spot the doctor wants to bombard.

High Voltage Engineering Corporation, manufacturers of this generator, at first had difficulty finding a high-voltage electrical insulating material for the gun barrel, a material that would stand electron bombardment hour after hour without breaking down. The answer to their problem was a glass selected from the many developed by Corning to meet exacting electrical specifications.

Providing glass for medical research is not new to Corning. Since the early days of X-rays, glass by Corning has played a vital part in the development of X-ray apparatus —transmitting glasses for tubes and absorbing glasses for shields. And Pyrex brand laboratory and pharmaceutical glassware has served medical science since World War I.

Throughout industry, *Corning means research in glass*—research that has contributed in countless ways to better products and processes, and through them, to better living for us all.

**That's why we suggest**—when you're out of college and concerned with improving products or processes—that you consider glass, a material of practically limitless uses. And should you want to know more about Corning electrical glasses, or the hundreds of other glasses Corning makes, we hope you'll write us before your planning reaches the blueprint stage. **Corning Glass Works**, Corning, New York.

**CORNING**
**means research in glass**

# STRESS and STRAIN...

A story from last Christmas: Two of Basil's friends were approaching his gaily lit house.

"Look," said one, "Basil has not forgotten a single Yuletide touch. See—the holly-covered windows, the sprig of mistletoe, the old-fashioned candle-lighted tree, even a group of children to sing Christmas carols. And look—they're even carrying in a Yule log."

"That's no Yule log," said the other. "That's Basil."

* * *

*Another professor was saying, "Here you have the skull of a chimpanzee, a very rare specimen. There are only two in the country—one in the National Museum, and I have the other."*

* * *

There was once an incredible optimist who never lost the opportunity to make a cheerful remark, even in the worst possible situation. But when his wife ran away with his best friend, and took his money, and burned down his house, no one thought he'd have anything cheerful to say, until they saw him get down on his knees, and say:

"Thank God I'm not a bigamist."

* * *

A ragged old individual was found sitting on the curb, weeping copiously. Someone stopped to ask him what was the trouble.

"It's my father," he blurted. "My father is a failure."

"Cheer up, cheer up, maybe he's not such a failure as you think."

"Oh yes, he is," said the old man. "He's been trying for thirty years to make me a gentleman, and I'm still an engineer."

* * *

We believe in clubs for women —provided everything else fails.

There was an angry yelp from the bathroom.

"What's the matter?" called his wife. 'It's my razor," he yelled. "It won't cut at all."

"Oh nonsense," she said. "Your whiskers can't possibly be tougher than the linoleum."

* * *

Two intoxicated gentlemen wandered into a public dance hall. One asked the location of the cloak room, and was told to take the first door to the right and to go down three steps. Due to the liquor-clogged condition of his brain, he got the elevator door by mistake and fell five floors to the basement. His friend watched his departure, and, leaning through the door, called out:

"What are you doing down there?"

"Hanging up my coat. Look out for that first step. It's an awful one."

* * *

A young woman tourist was spending the night in a Texas hotel. She was asking the clerk for sights to see of unusual interest.

"Well," said the clerk, "we have the only helium plant in the world."

"How wonderful. Is it in bloom now?"

* * *

*"It's so dark in here," said one tonsil to the other.*

*"We must be in Capistrano," said the second, "here comes another swallow."*

* * *

"Really," whispered the gushing girl to the ardent engineer. "Really if I refuse to marry you, will you really commit suicide?"

"That," he said with great dignity, "has been my usual custom."

"I just bought a skunk."

"Where you going to keep him?"

"Under the bed."

"What about the awful smell?"

"He'll have to get used to it just like I did."

* * *

*And the other side of a joke we printed a while back:*

*Outside the toy factory the storm raged furiously. Inside the machines were silent.*

*"Why aren't you turning out your quota of toy animals?" said the owner to the foreman.*

*And the foreman replied, straining his voice so that he could be heard above the gale, "I wouldn't turn a dog out on a night like this!"*

* * *

E.E. Lab Instructor: "Catch hold of this wire."

Student: "Got it. What now?"

Instructor: "Feel anything?"

Student: "No."

Instructor: "Well then, don't touch the other one. It carries twenty-three hundred volts."

* * *

*"Ah," sobbed Nanamiva Nadivya Mabablavivitch, "so Ivan is dead. And you say that he died with my name on his lips?"*

*"Well," replied the informant, "part of it."*

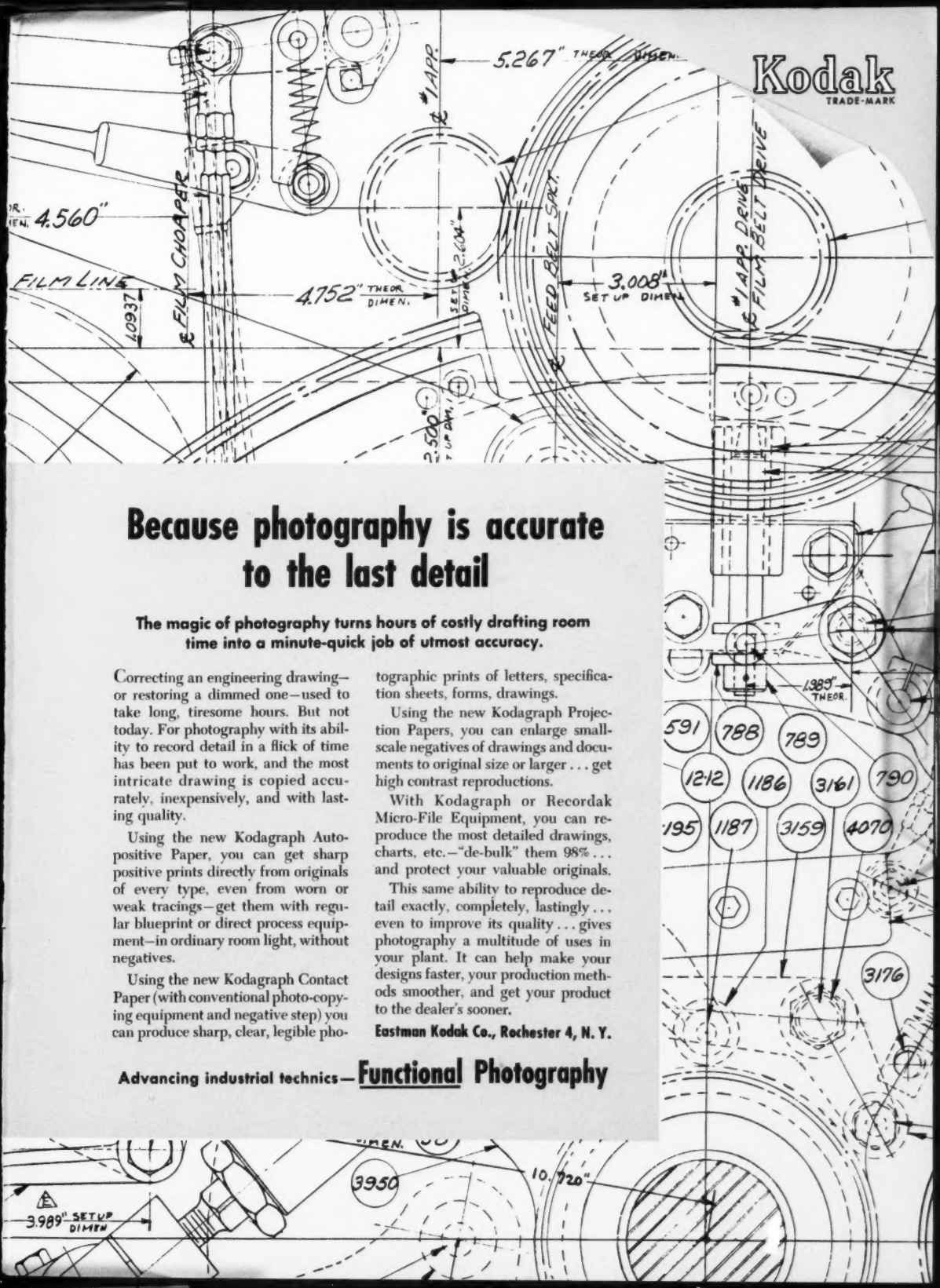
* * *

"Who was that lady I saw you with in a sidewalk cafe last night?"

"That was no cafe—that was our furniture."

* * *

*"I shall now illustrate what I have on my mind," said the professor as he erased the blackboard.*

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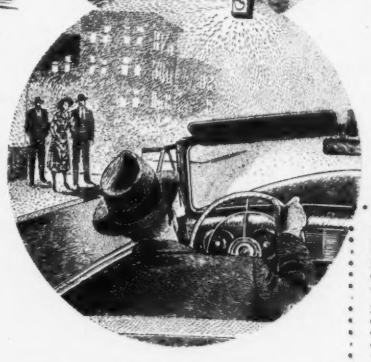
Now streets can be lighted by G-E fluorescent lamps. The four lamps in each fixture produce 19,000 lumens of light.

Two entire communities have voted to let G-E Disposalls take care of their garbage. Young G-E engineer Gordon Roney (R.P.I., '36) has supervised installation.



New G-E electronic traffic control automatically adjusts time lights stay red or green to accommodate greatest traffic flow.

Ithaca, N.Y.
Permit No. 1/6

# These G-E developments are bringing a "New Look" to American communities

Jasper, Indiana, has no garbage collection any more. It became the first town to get rid of garbage by letting General Electric Disposall® food-waste units grind it up and flush it down the drain. A young G-E engineer who has specialized in Disposalls since he came off the Company's "Test" course supervised the installation of Jasper's units and is now starting a similar job for Herrin, Illinois.

In Detroit, other G-E engineers have installed something new in street lighting—fluorescent street lamps. Used primarily indoors before, fluorescent lamps are now used to light a half-mile of the city's Wyoming Avenue. Their light is brighter, less glaring, and is expected to make driving safer.

Still other G-E experts have revolutionized Denver's downtown system of traffic-light controls. The new system counts passing cars and automatically varies the length of time that red and green lights stay on, thus adjusting the lights to changes in the traffic flow.

These are a few examples of the exciting new projects that are challenging young G-E engineers today. General Electric's leadership in research and engineering makes it a place where college graduates are finding increasing opportunities to engage in highly interesting and satisfying work.

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